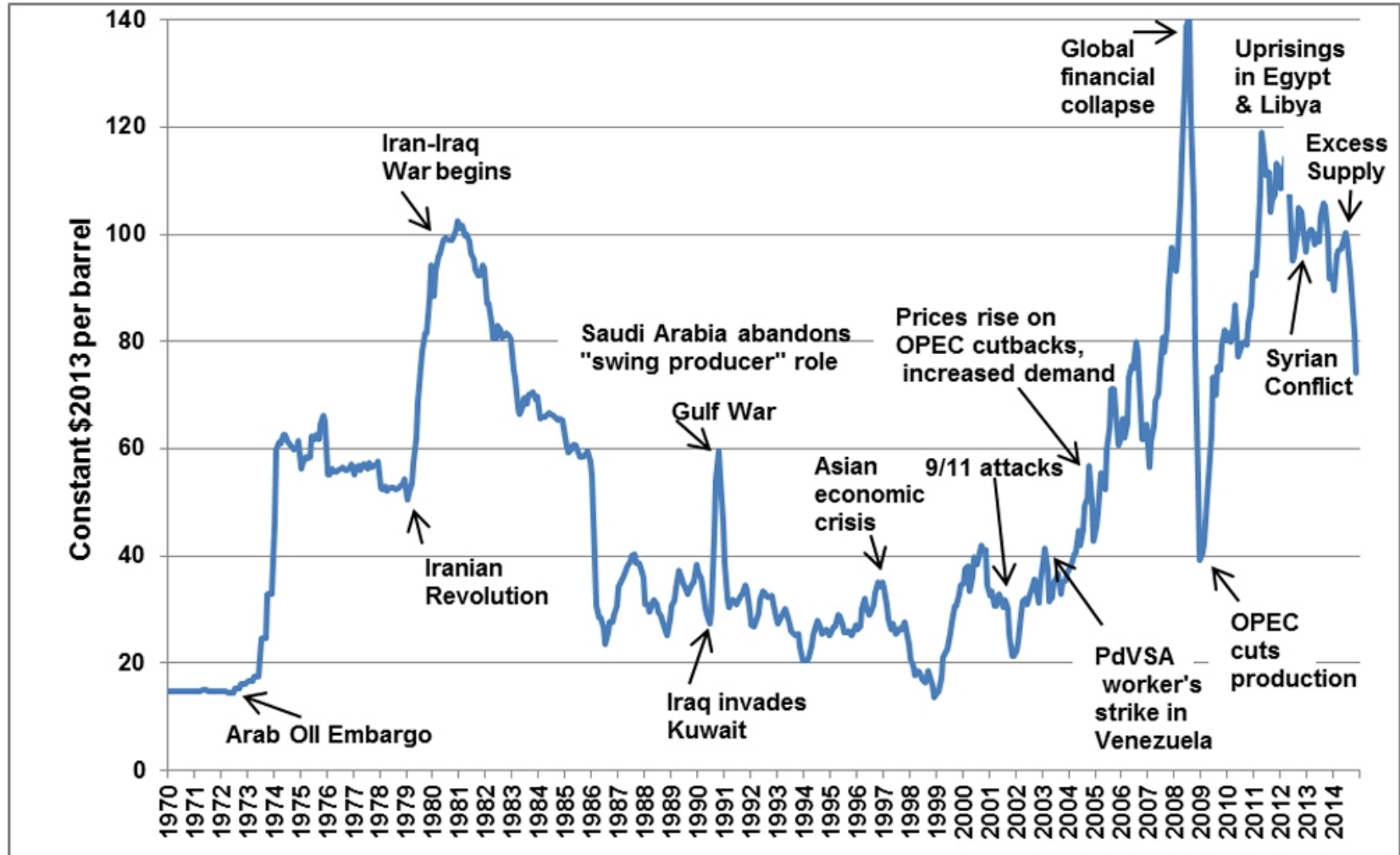


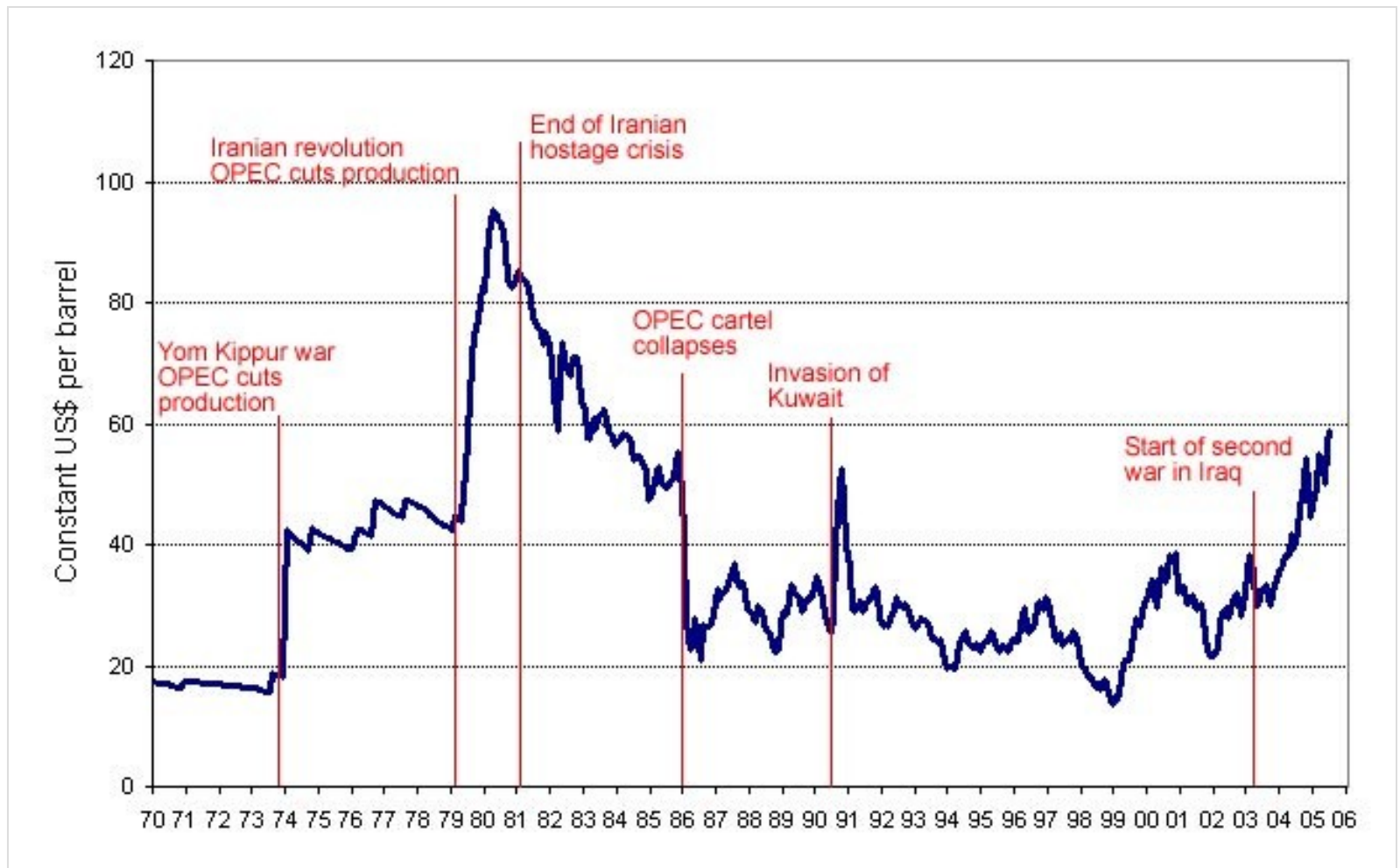
Energetické suroviny

Nerostné zdroje
světa, fossil fuels
part 02,
hydrocarbons, ...

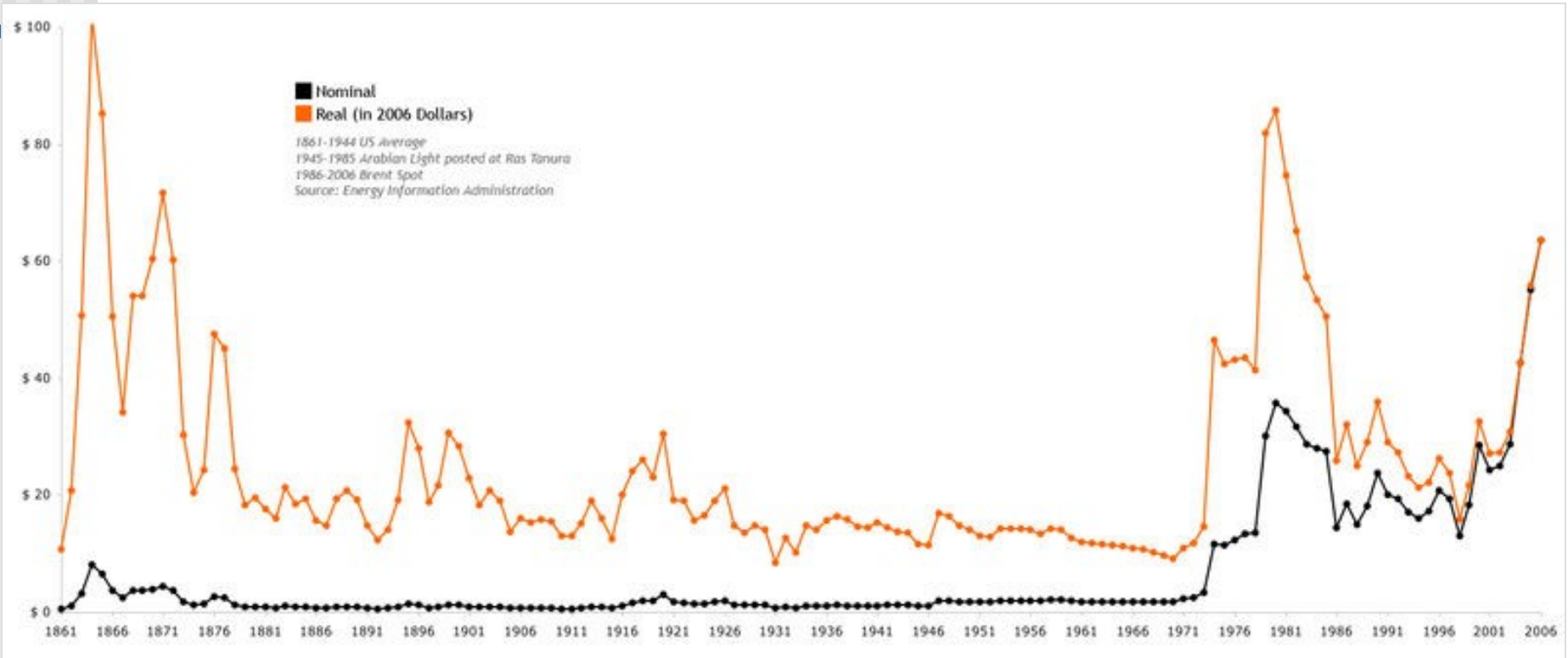
Ropa – strategická surovina



Ceny a mezinárodní konflikty

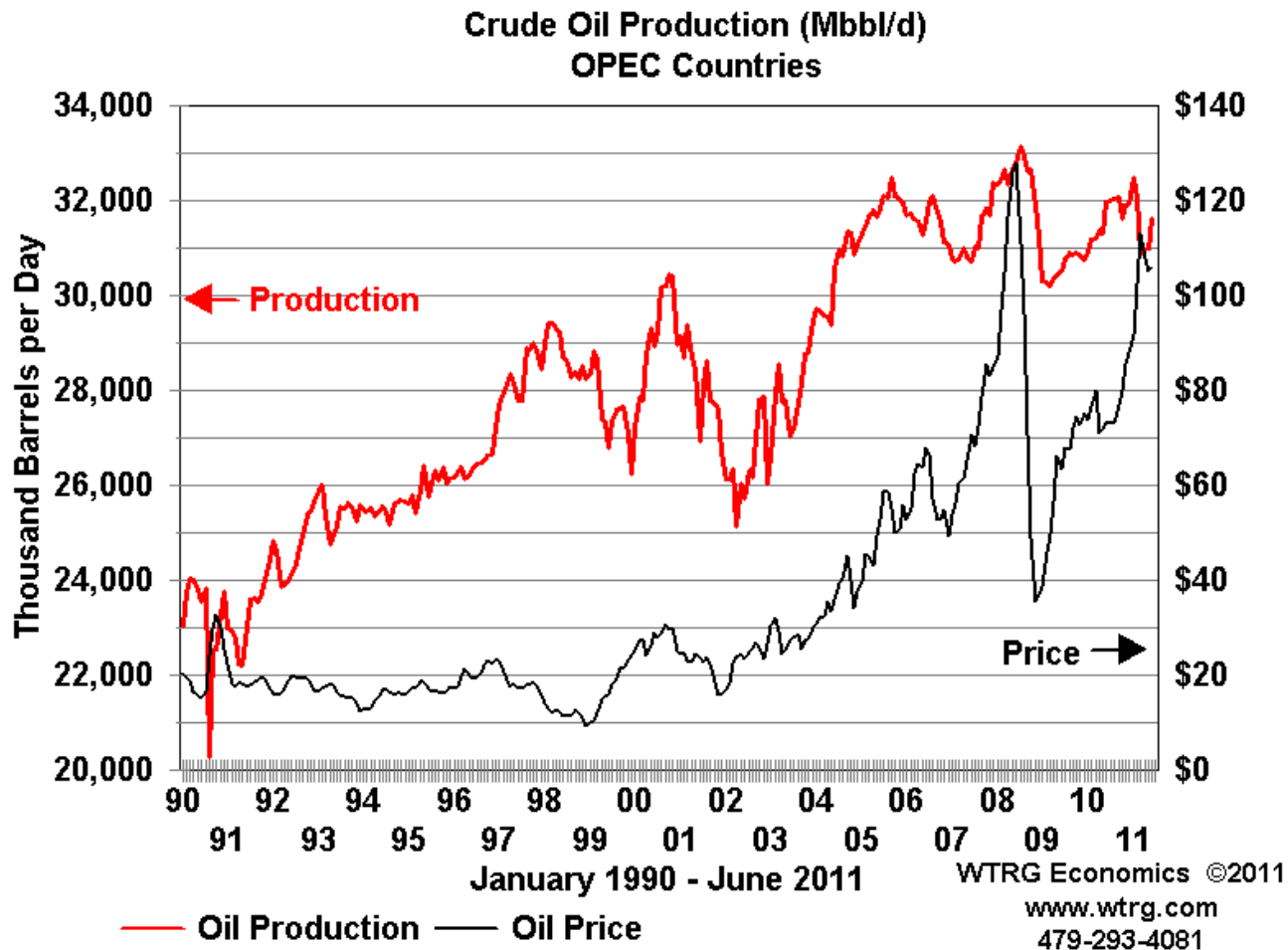


Historie cen ropy



<http://www.wtrg.com/prices.htm>

Produkce - cena



Geneze kerogenu

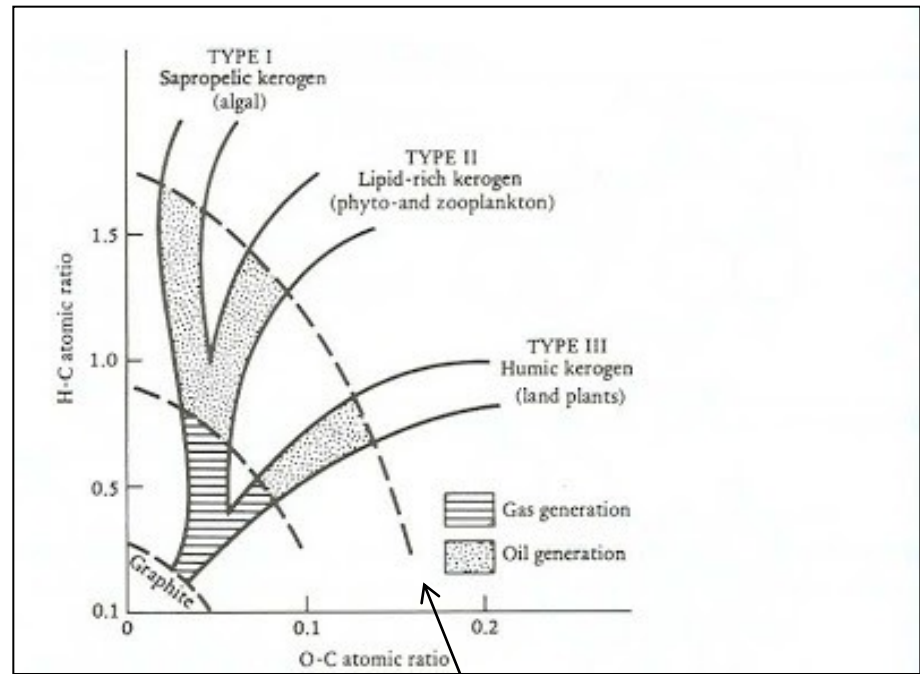
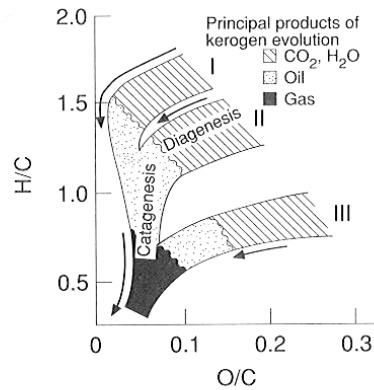
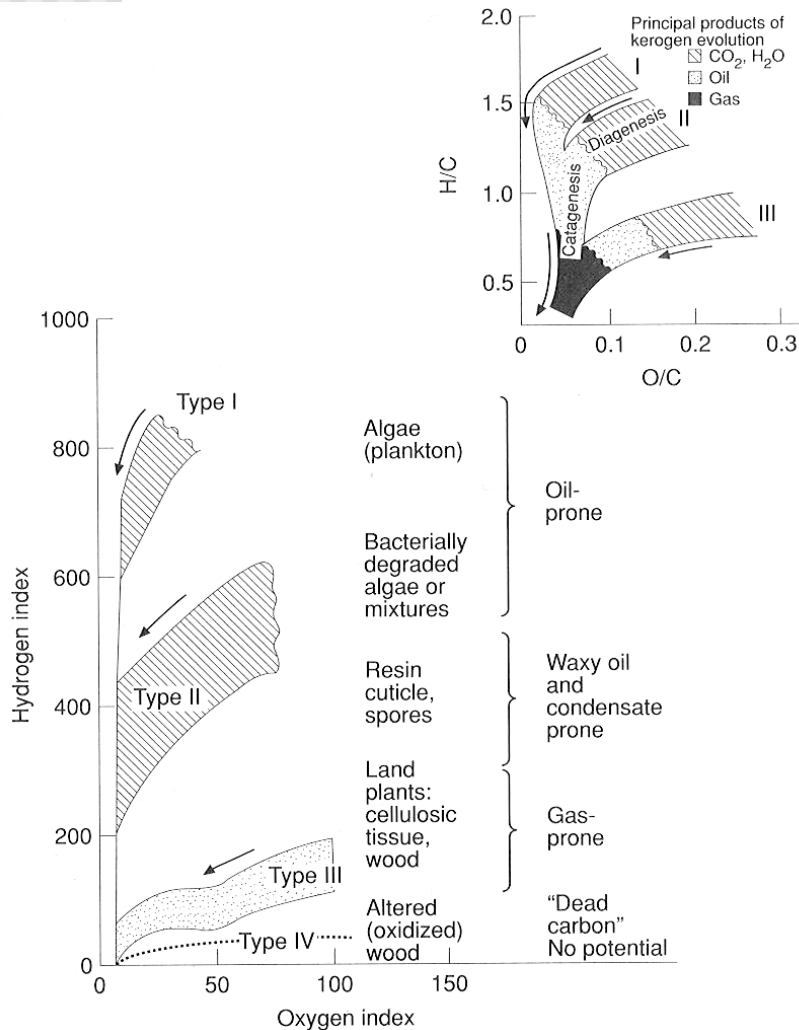


Figure 5.29 Classification scheme for kerogen types based on the hydrogen index and oxygen index (after Cornford, 1998). Inset diagram shows the original classification of kerogen on the basis of H/C and O/C atomic ratios (after Tissot and Welte, 1984).

vznik geopolymérů a krakování

(Robb 2005)

Vznik uhlovodíků

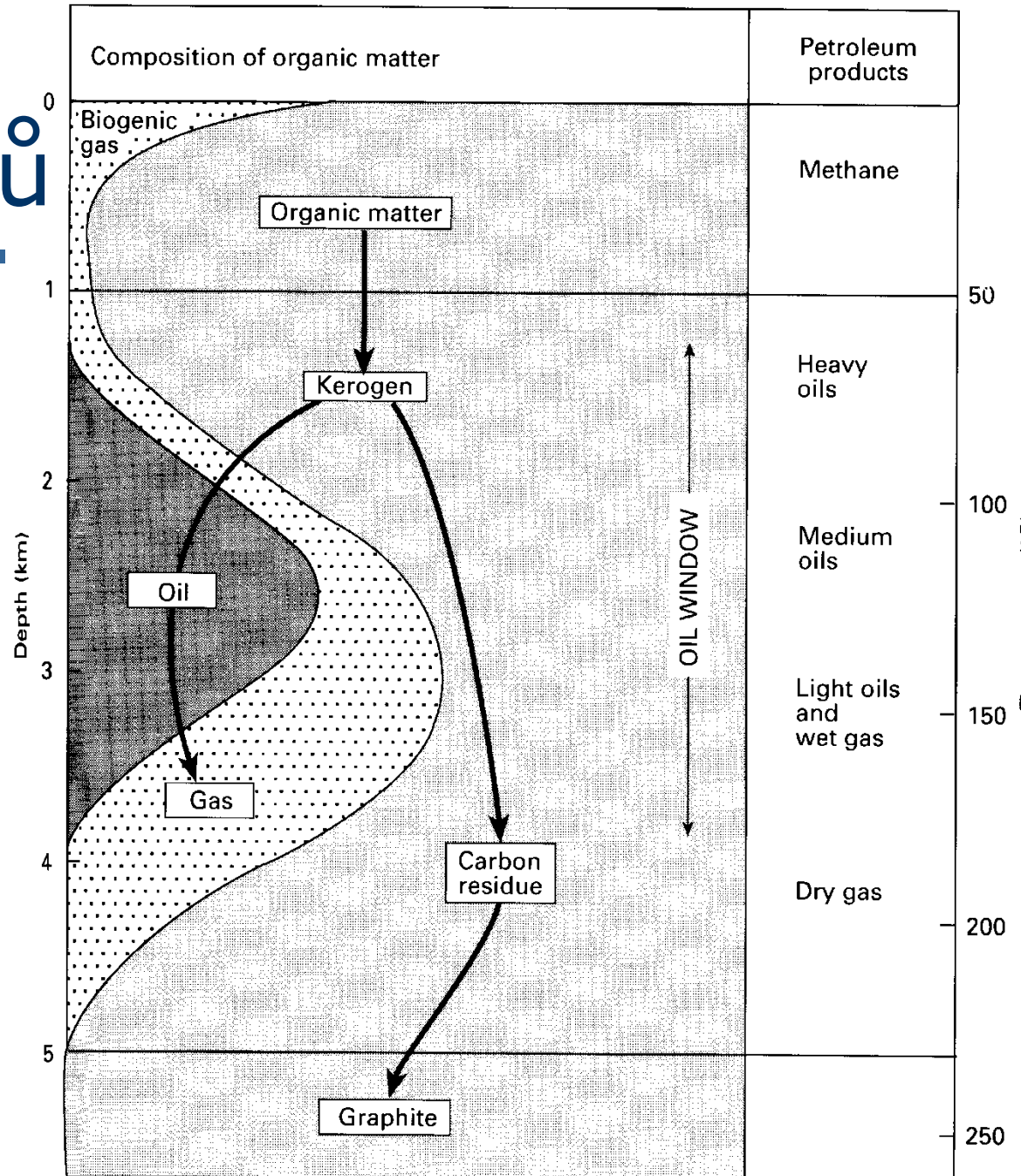


Fig. 25.5 Organic matter diagenesis showing the relationship between temperature, depth of burial and the petroleum products formed.

Ropa - oblasti

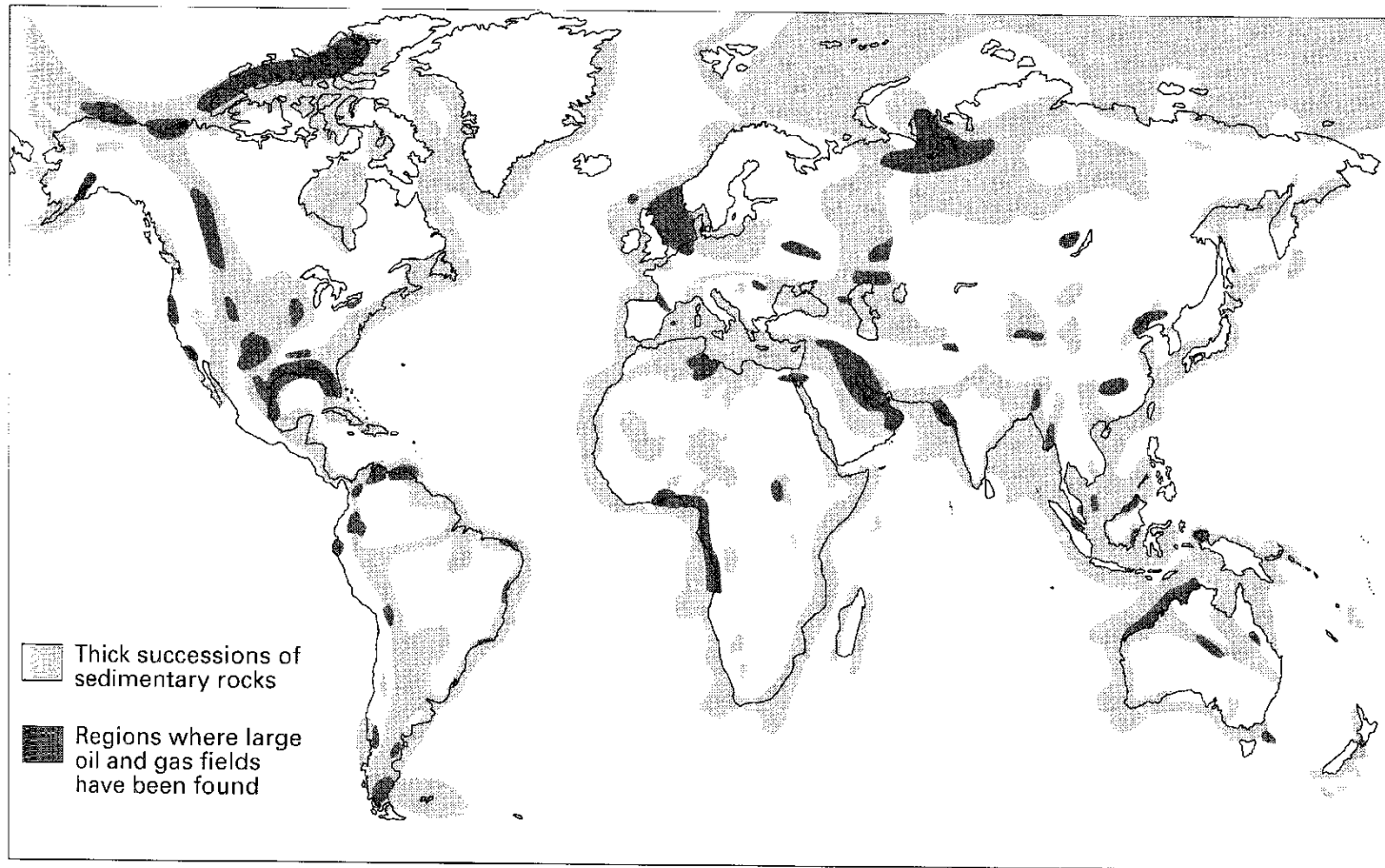
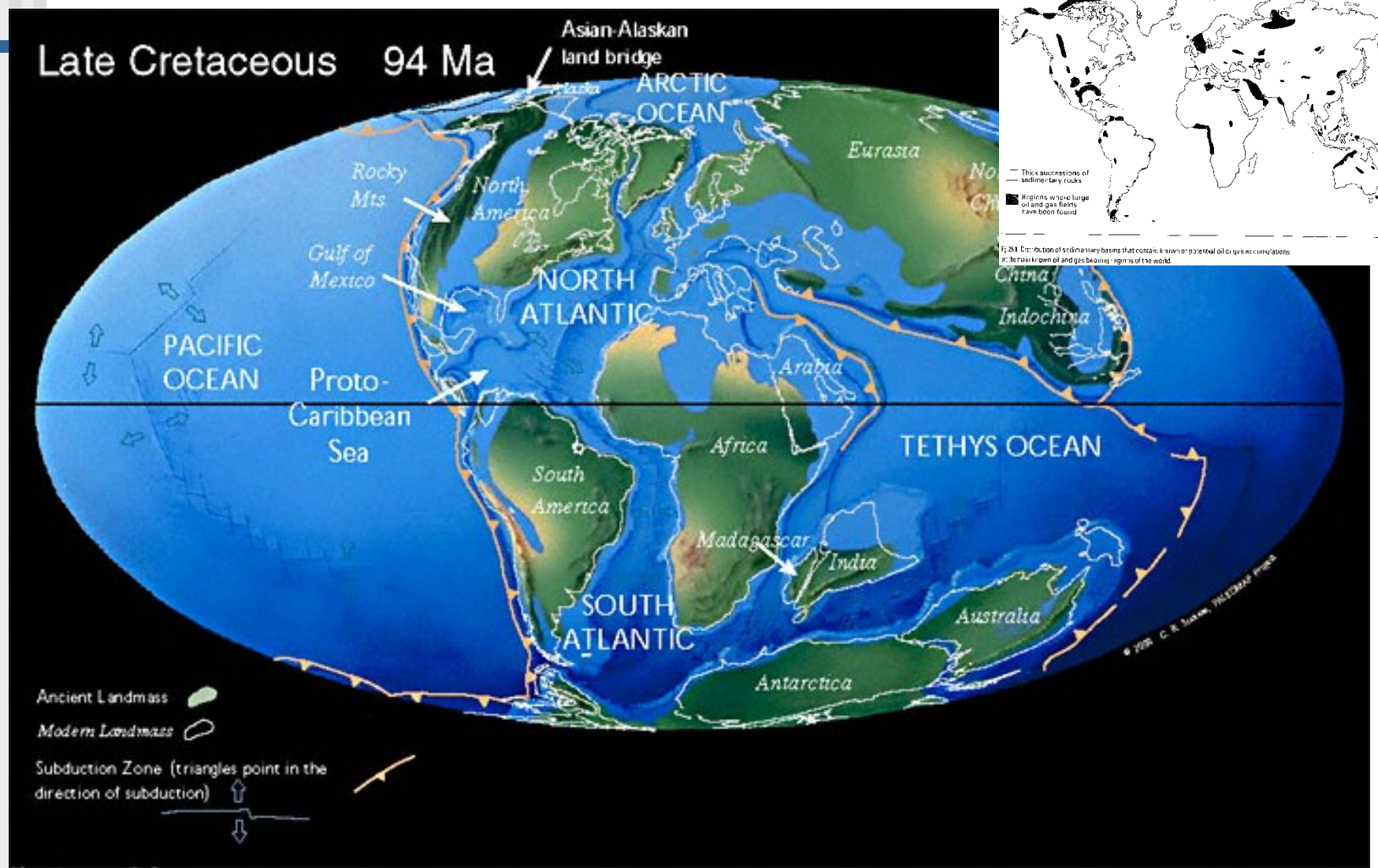
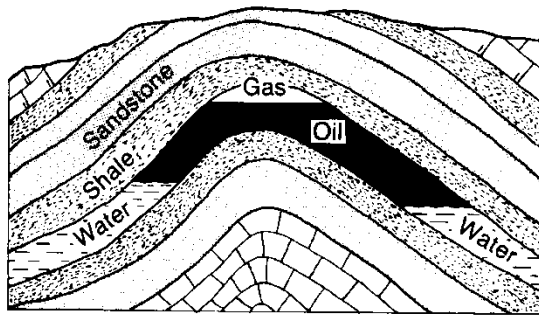


Fig. 25.1 Distribution of sedimentary basins that contain known or potential oil or gas accumulations and the main known oil and gas bearing regions of the world.

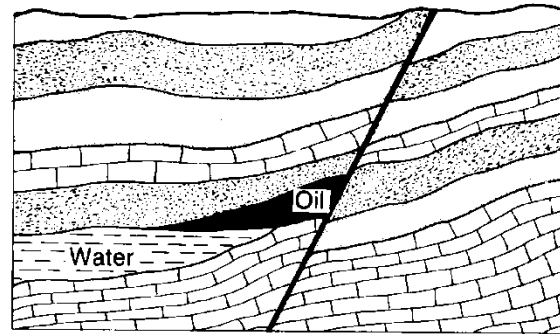
Vznik uhlovodíků - paleogeografie



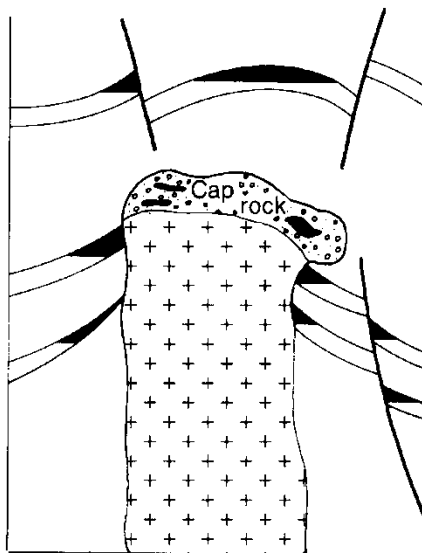
Ropné pasti - ložiska



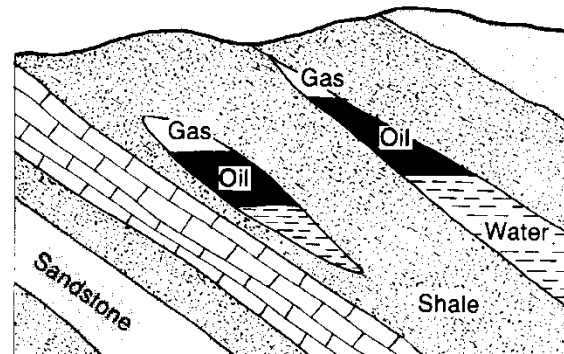
(a)



(b)



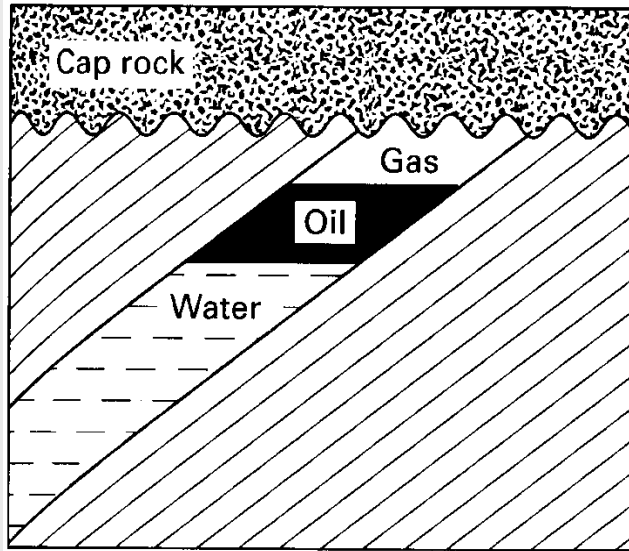
(c)



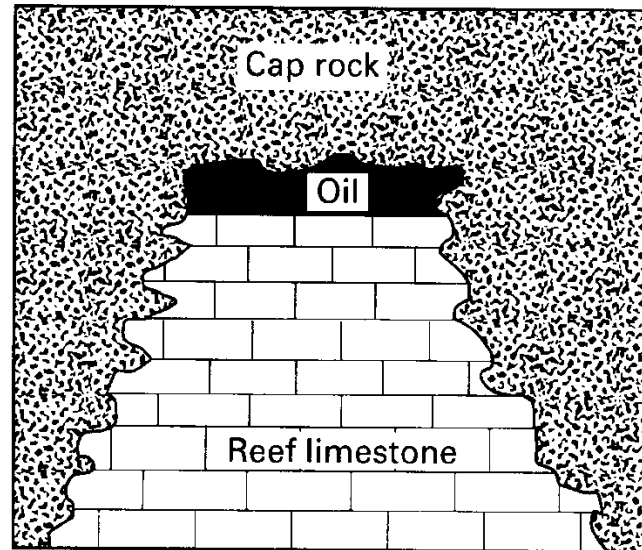
(d)

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.

Ropné pasti II.



(a)



(b)

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

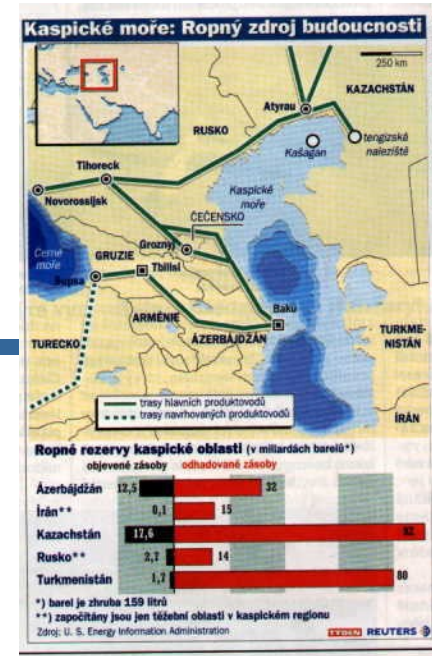
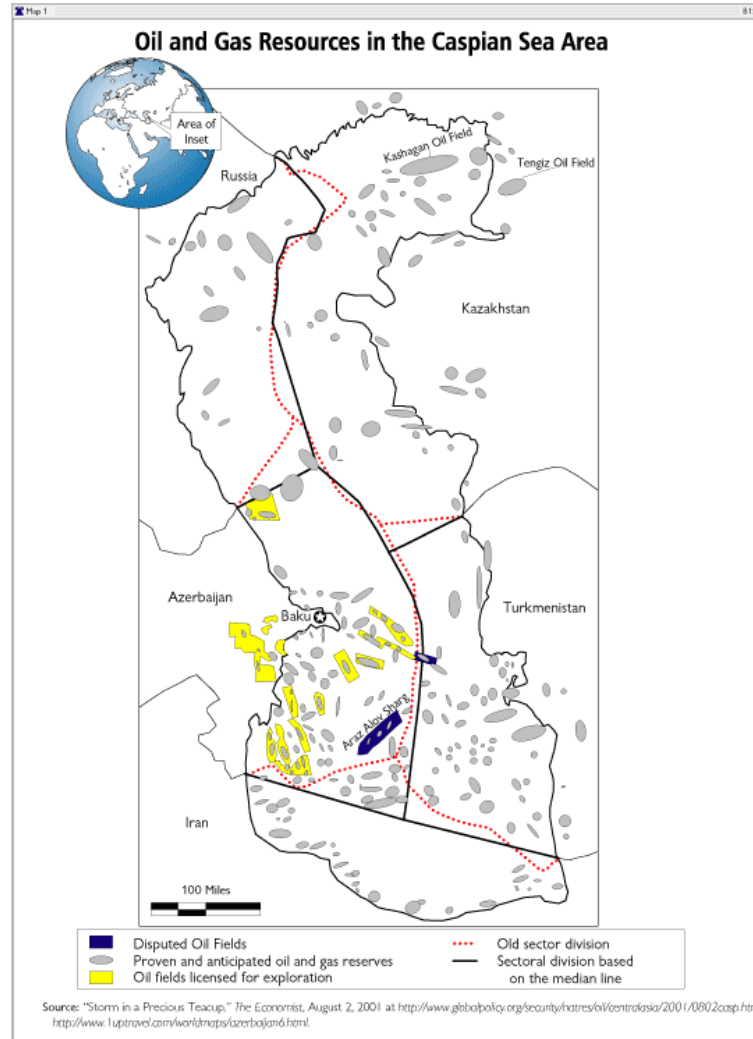
Nejvýznamnější produkční oblasti

- Perský záliv
- Severní moře
- Rusko (z.Sibiř)
- jv. Asie
- severní Afrika
- ...

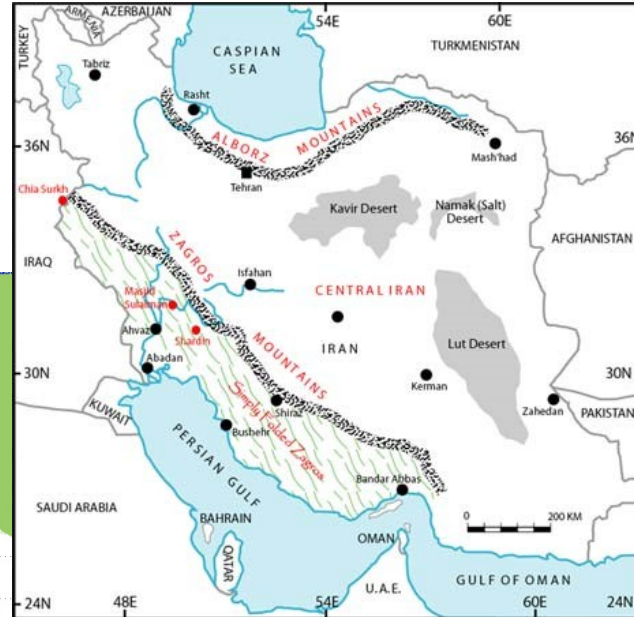
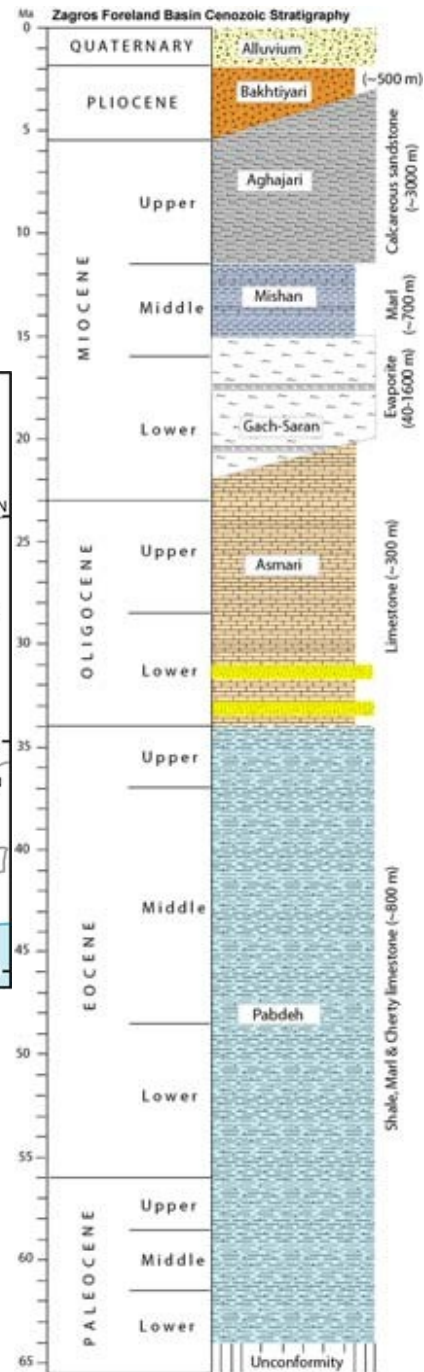
Kaspická oblast

v.Kaspického moře –
 poloostrov Mangyšlak, ploché
 vrásové struktury, pískovce
 sv.jury – ropa, klastika sp.křídý
 – plyn

z.pobřeží, Apšeronský
 poloostrov, oligocén, miocén,
 pliocén, (paleodelta Volhy)



Perský záliv

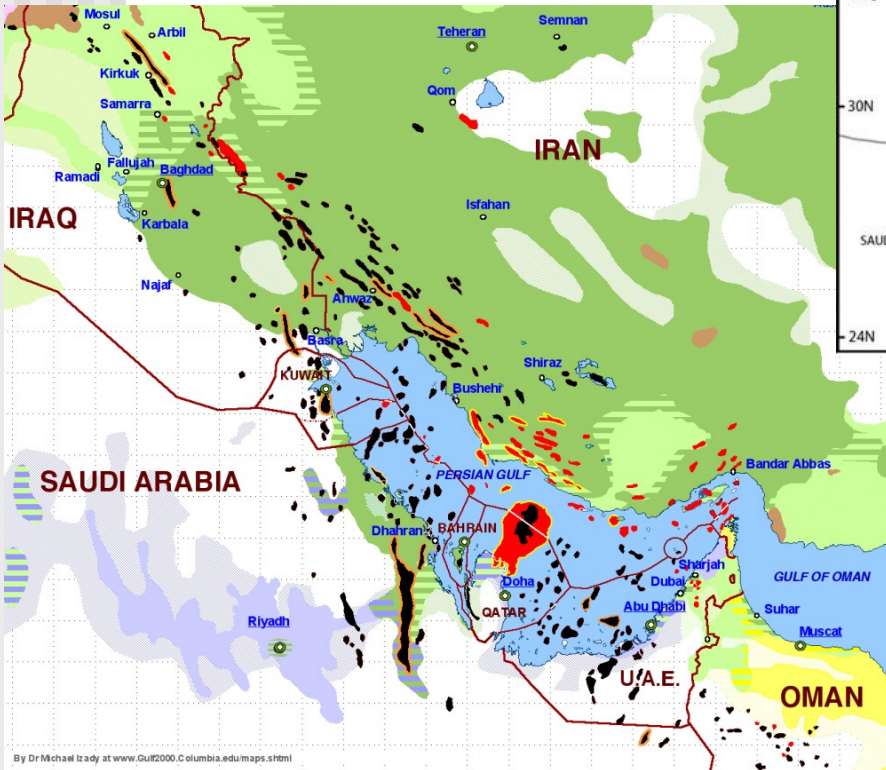


SA - Ghawar – karbonáty, jura, Safaniya – křída

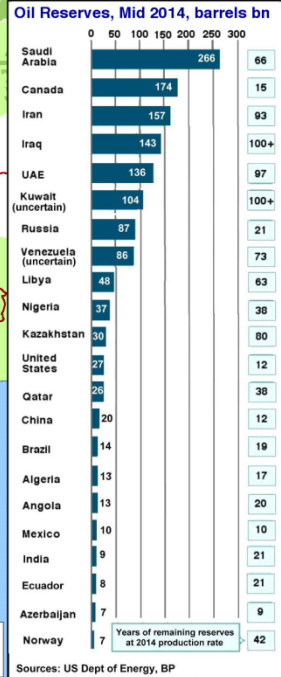
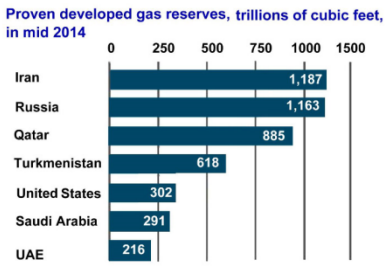
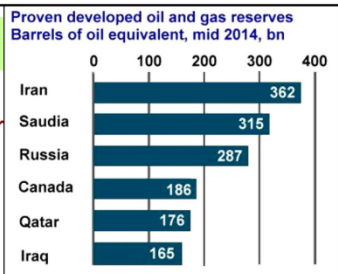
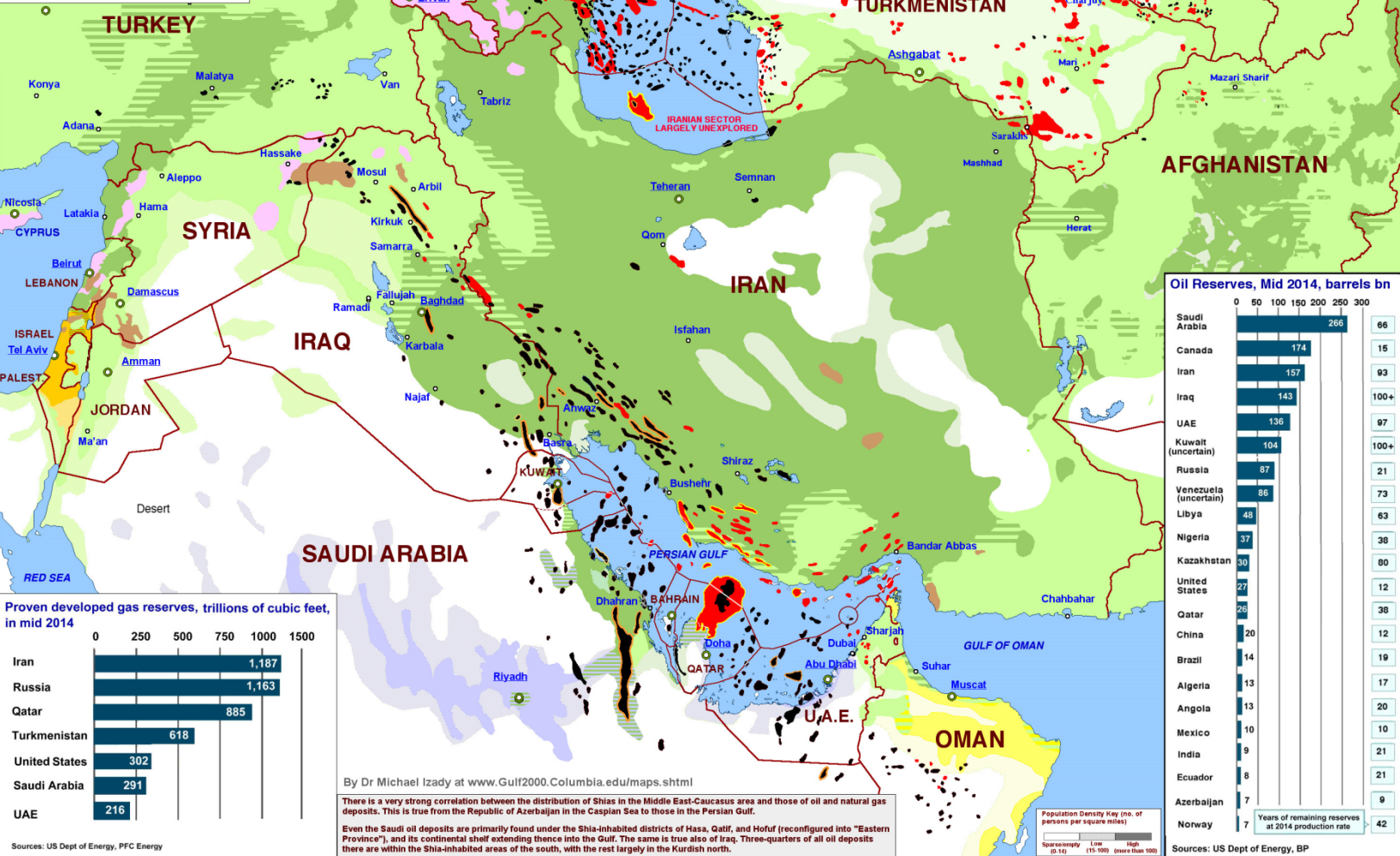
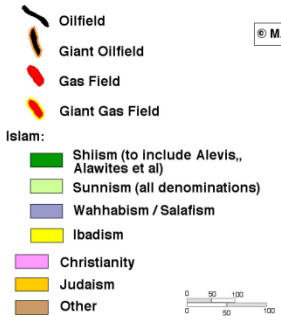
Irán – oligocén, miocén, antiklinální struktury vápenců

Irák – rozsáhlé antiklinály vápenců, eocén, oligocén

Kuvajt – ložisko Burgan, rozsáhlé ploché dómové struktury, křídové pískovce, hloubky 1000-1500m



Primary Oil and Gas Deposits of the Middle East and its Shia Majority Areas



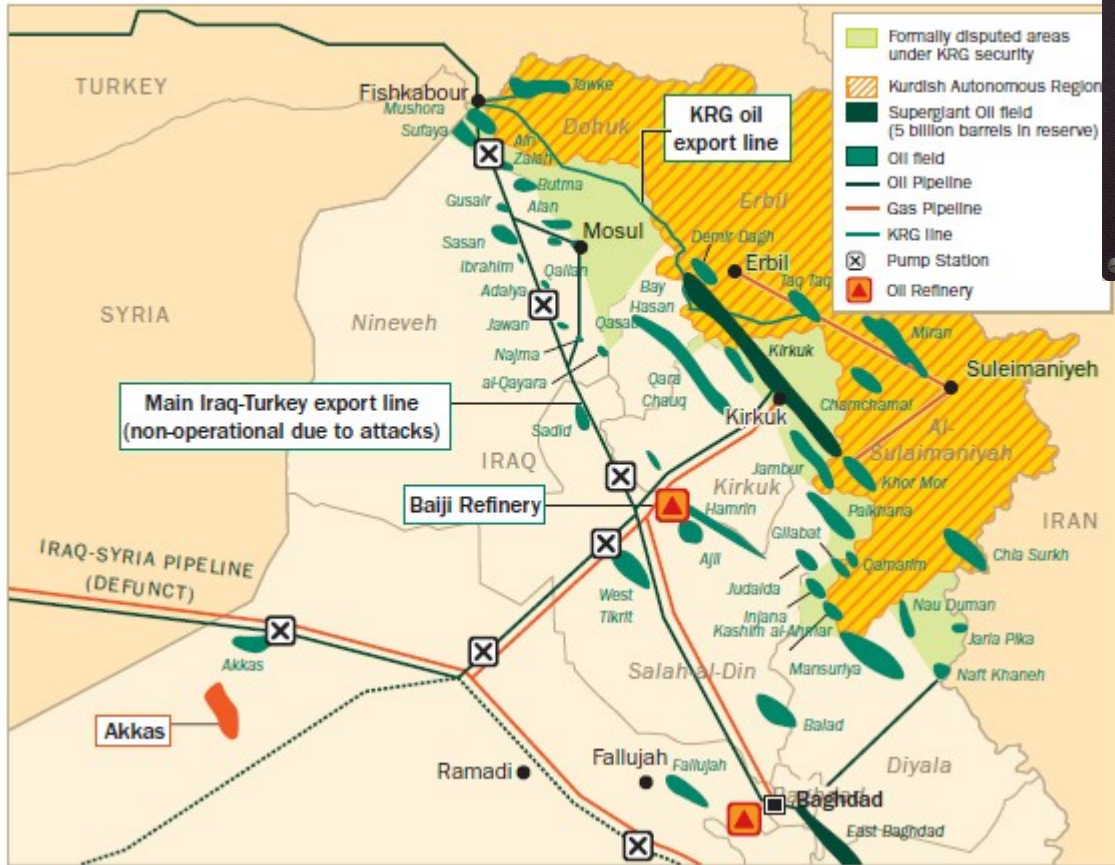
By Dr Michael Izady at www.Gulf2000.Columbia.edu/maps.shtml

There is a very strong correlation between the distribution of Shias in the Middle East-Caucasus area and those of oil and natural gas deposits. This is true from the Republic of Azerbaijan in the Caspian Sea to those in the Persian Gulf.

Even the Saudi oil deposits are primarily found under the Shia-inhabited districts of Hasa, Qatif, and Hofuf (reconfigured into "Eastern Province"), and its continental shelf extending thence into the Gulf. The same is true also of Iraq. Three-quarters of all oil deposits there are within the Shia-inhabited areas of the south, with the rest largely in the Kurdish north.

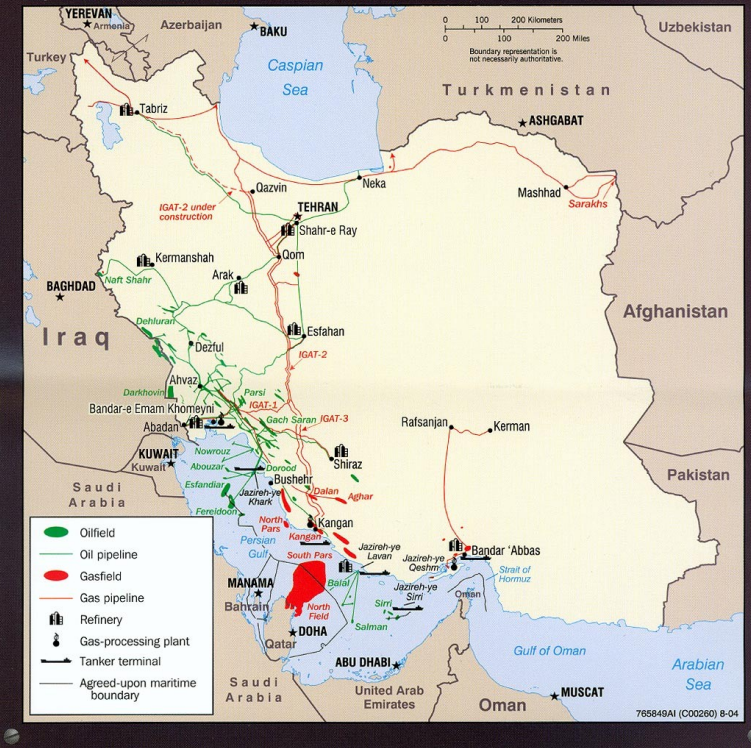
Perský záliv

Northern Iraq's oil infrastructure



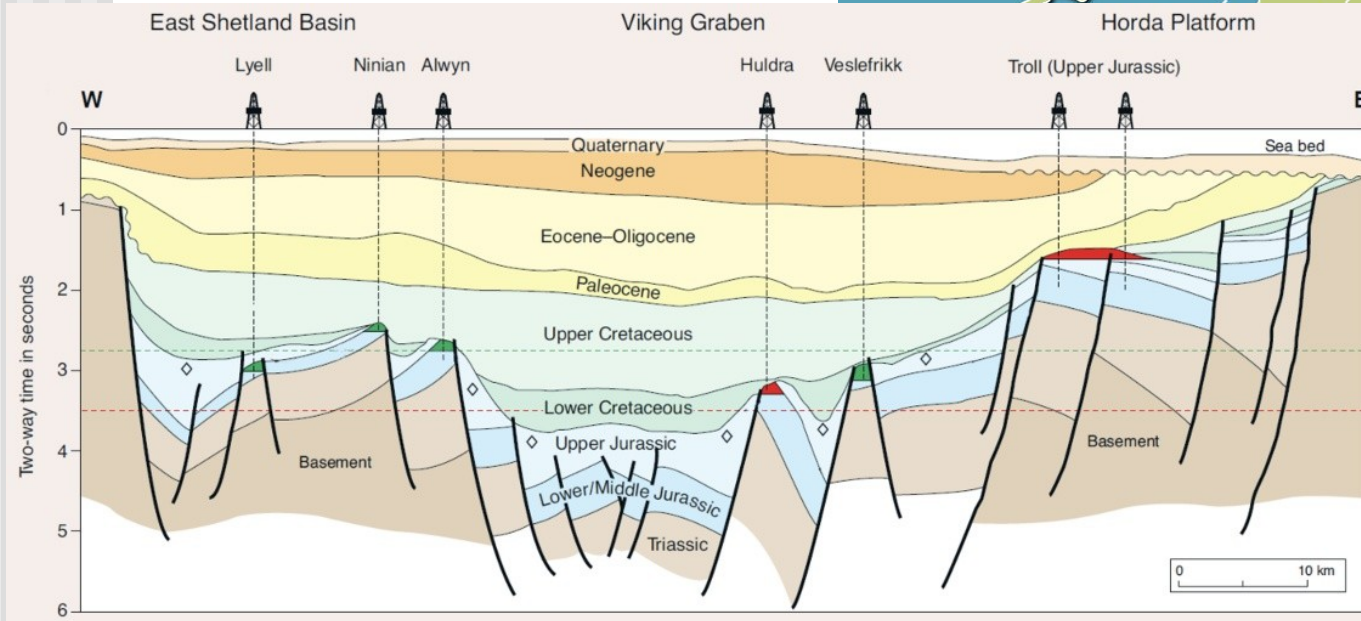
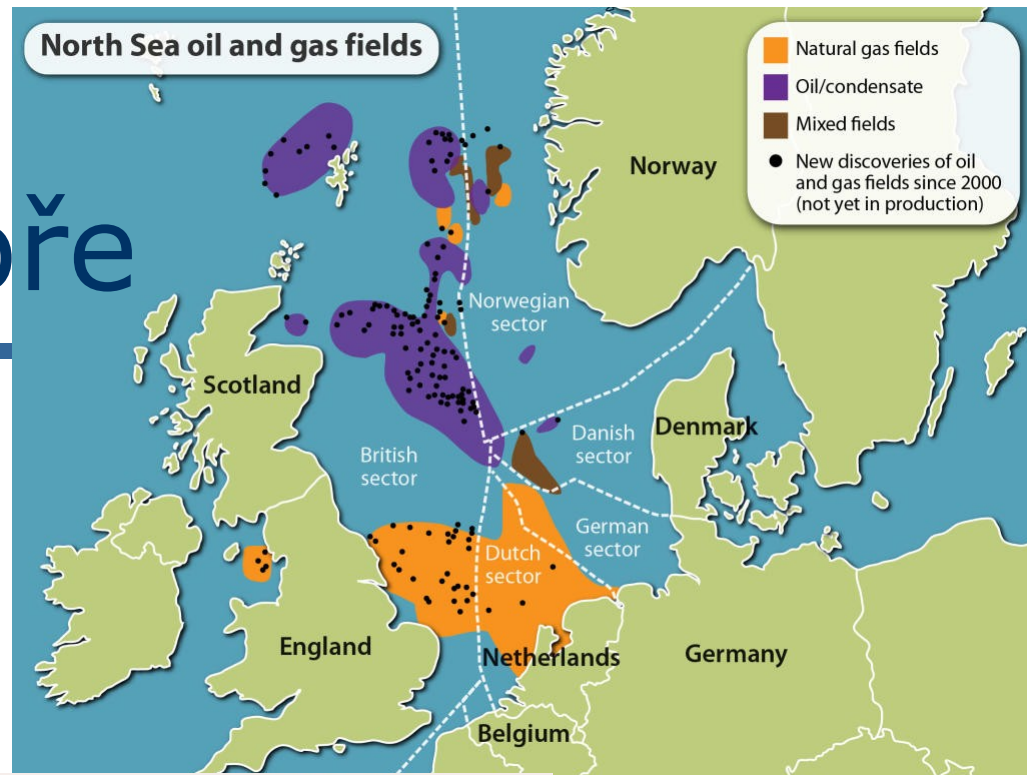
Source: Platts

Key Petroleum Sector Facilities

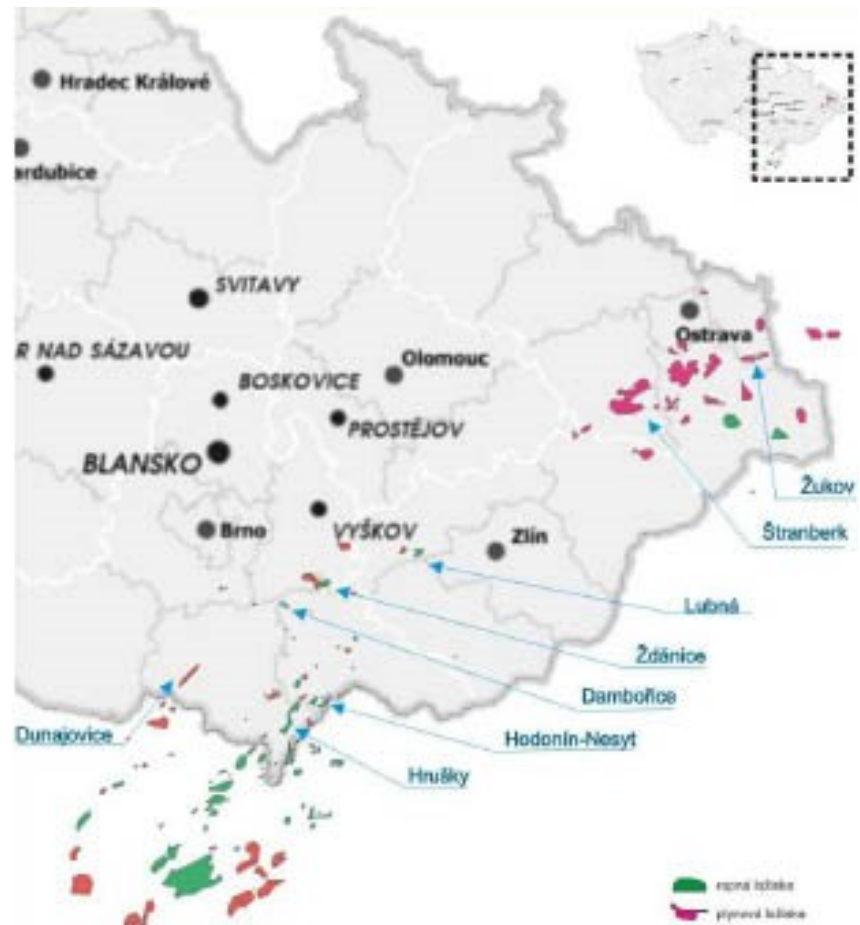


Severní moře

ploché antiklinální struktury,
karbonské dolomity, jurské
pískovce

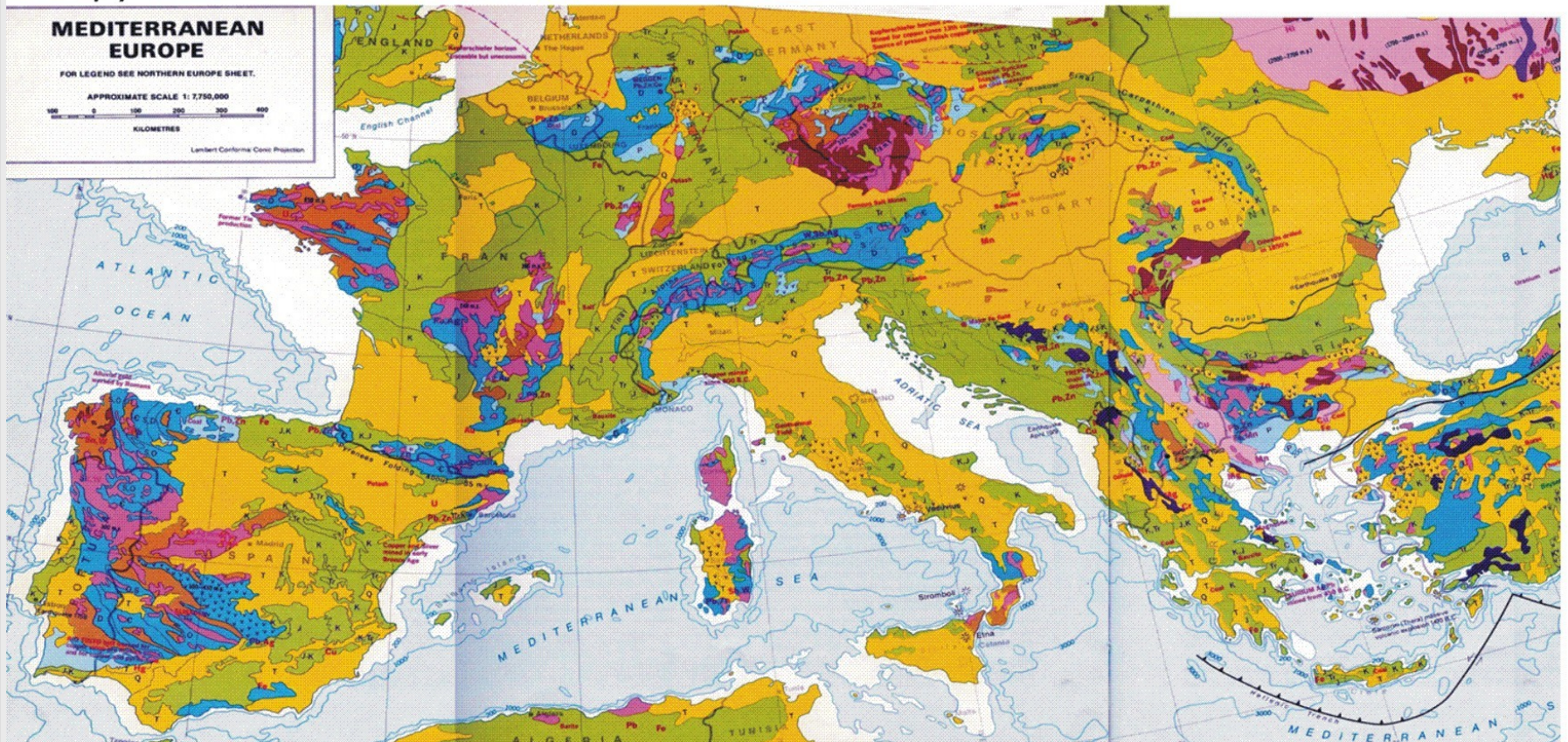


Ropa a zemní plyn v ČR

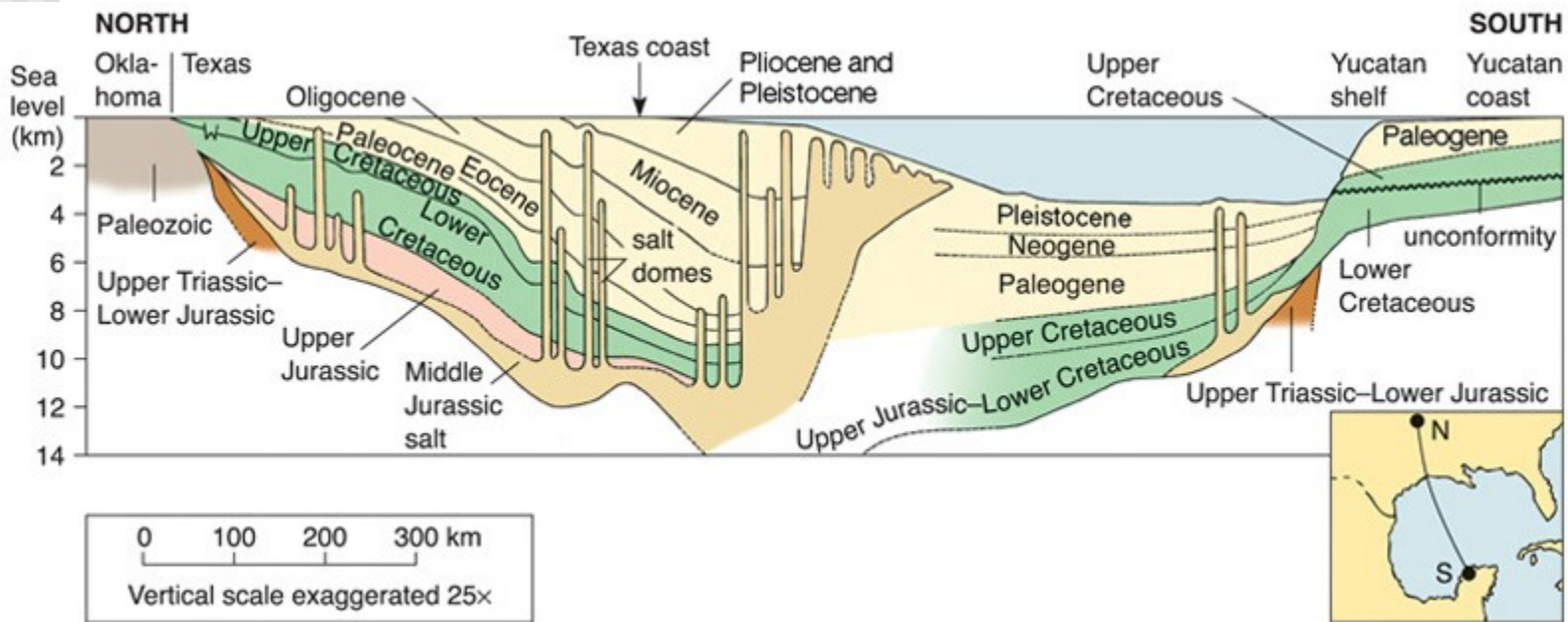


<http://www.petroleum.cz/ropa/vyskyt-ropy-soucasnost.aspx>

Obr. 11.2 Pozice Českého masivu a Karpatské soustavy v rámci geologické stavby Evropy



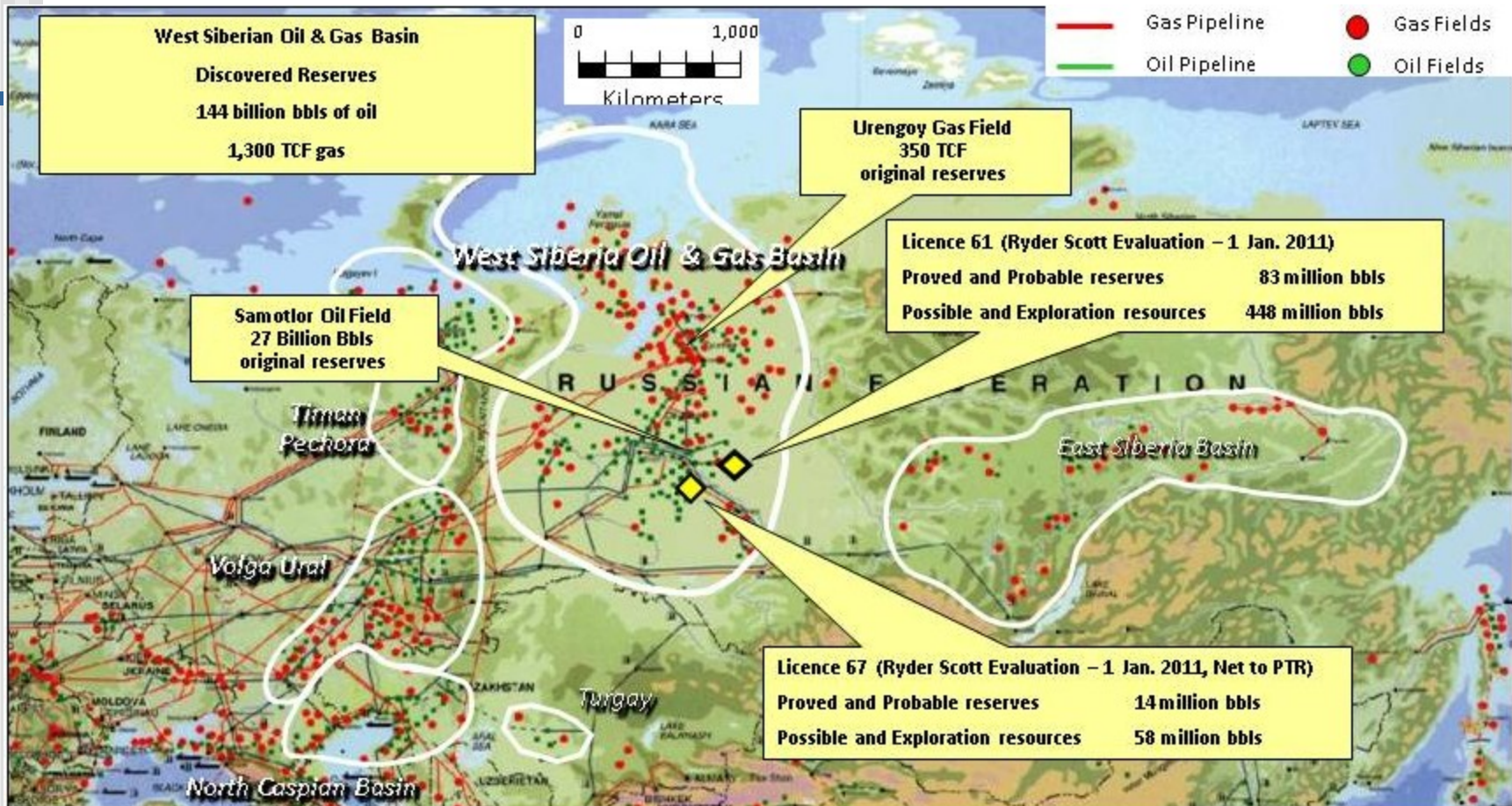
Mexico basin



Geologic cross section through the Gulf of Mexico basin.

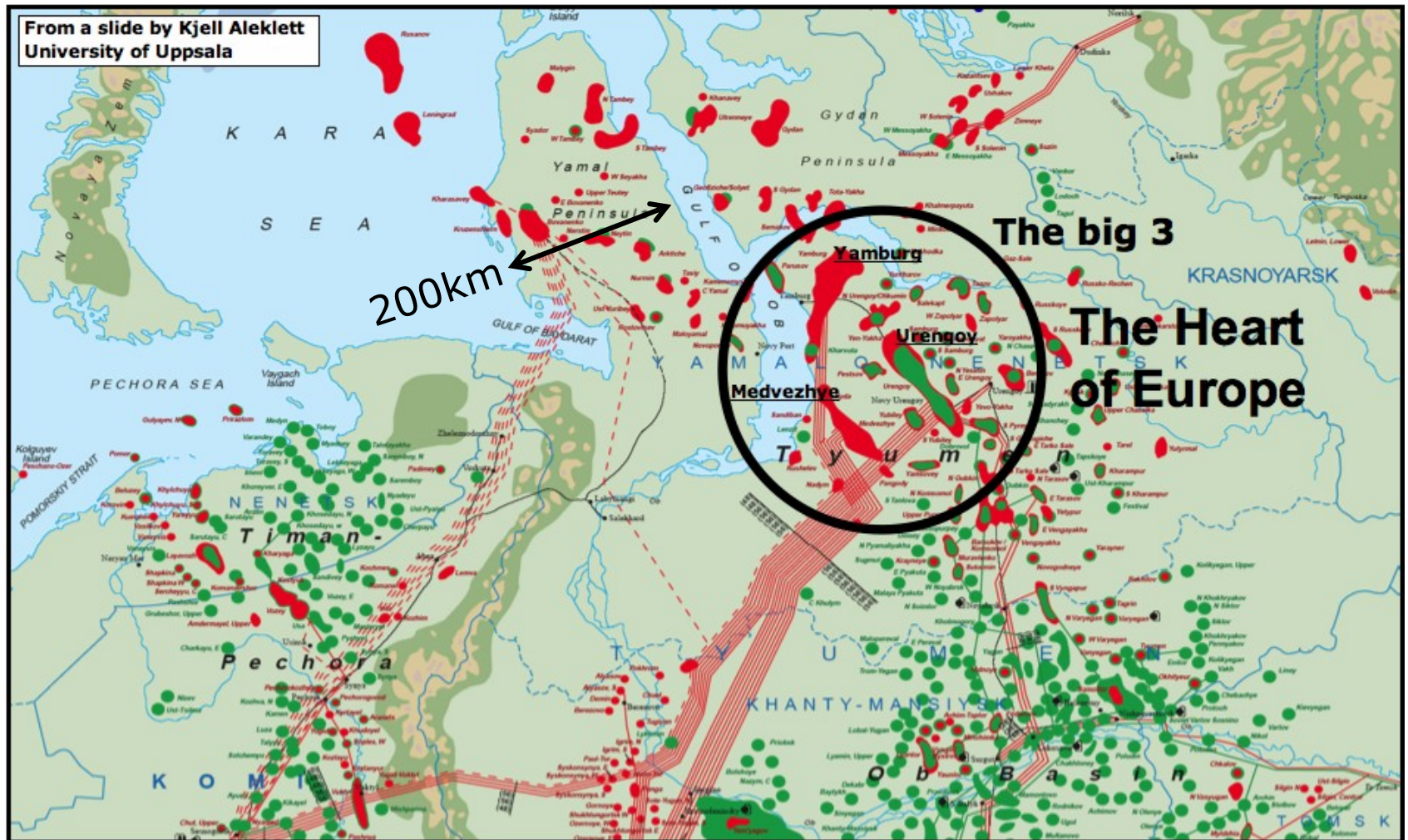
Rusko - uhlovodíky





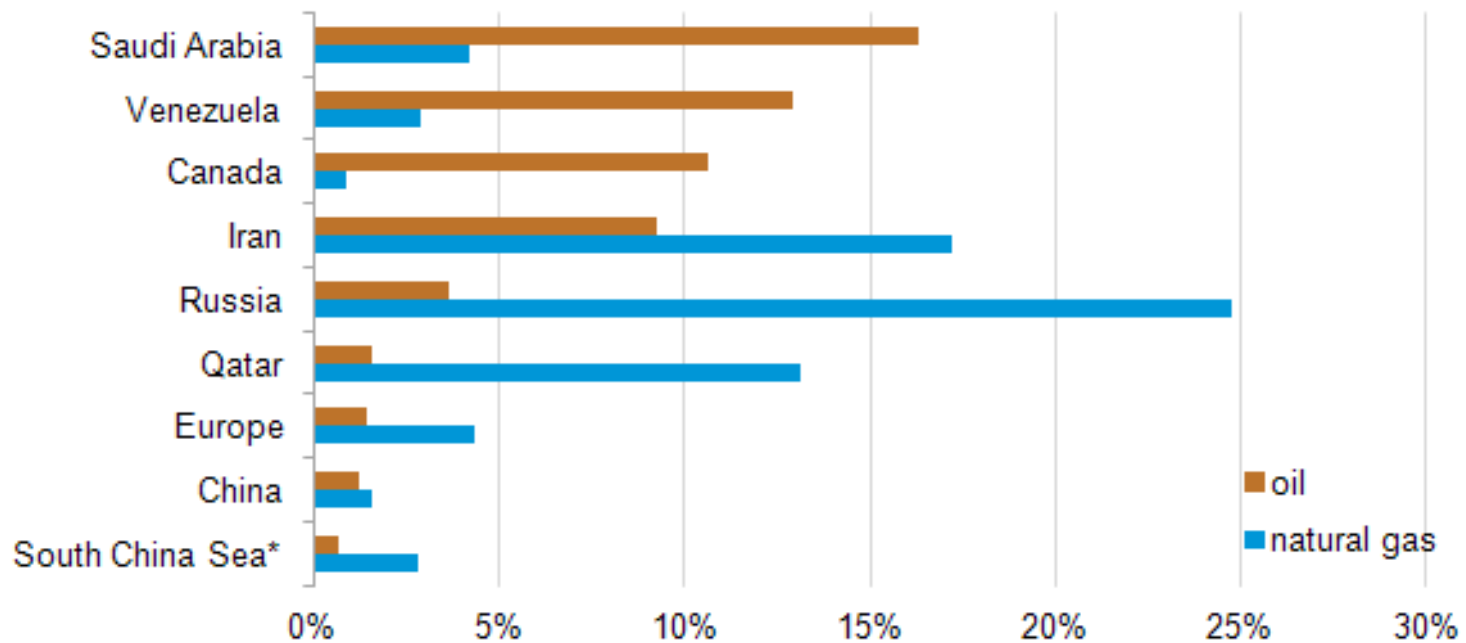
západosibiřská provincie – jurská a křídová klastika
 východosibiřská provincie – kambrické, prekambrické hor., permské a křídové sedimenty

Velká ložiska z.Sibiře



Oil and gas reserves

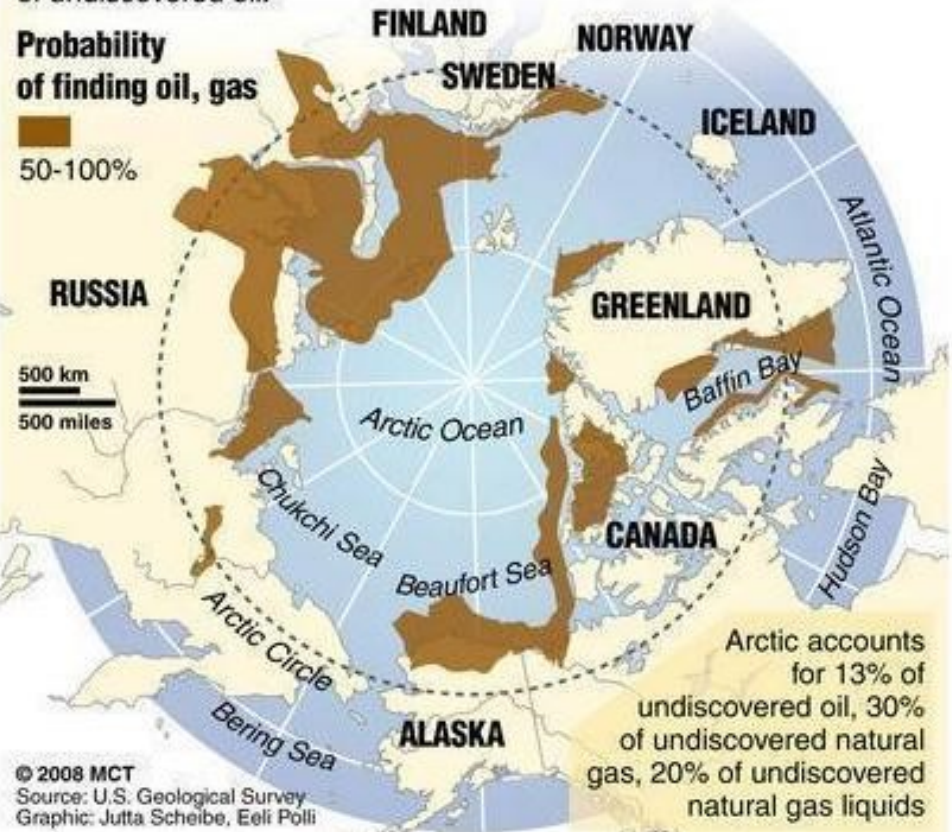
Share of world proved oil and gas reserves for select regions (2012)



Arktida

Oil and gas in the Arctic

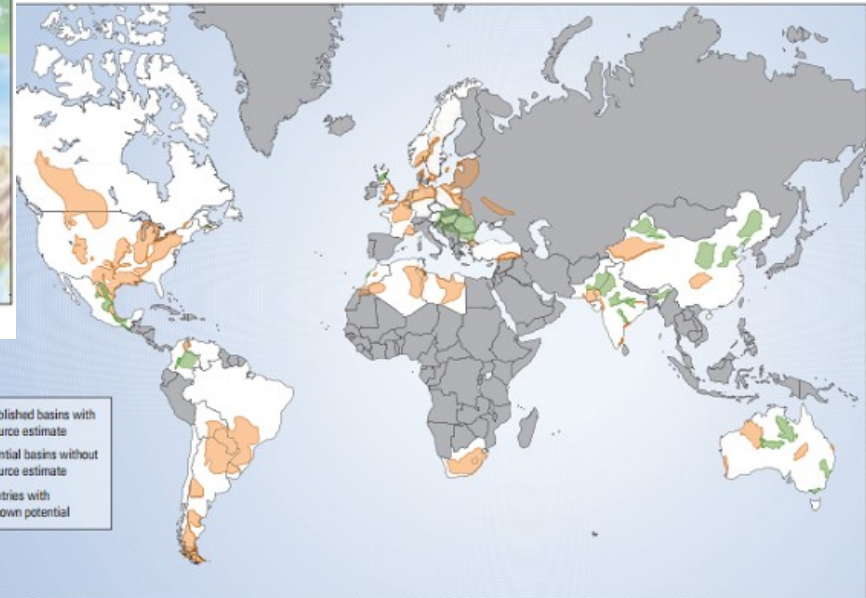
Area north of the Arctic Circle has an estimated 90 billion barrels of undiscovered oil.



Plyn z břidlic – „břidlicový plyn“ – shale gas



▲ Europe shale basins. (Adapted from Kuuskraa et al, reference 6.)



▲ Global shale gas resources. The US EIA studied 14 regions for shale gas potential. Vast land masses in Russia, the Middle East and Africa were not included in the report (gray shade). Reasons cited for not including these regions in the report were scarcity of exploration data or the presence of abundant reserves in conventional reservoirs, which make shale gas unattractive—for the present. (Adapted from Kuuskraa et al, reference 6.)

Čína

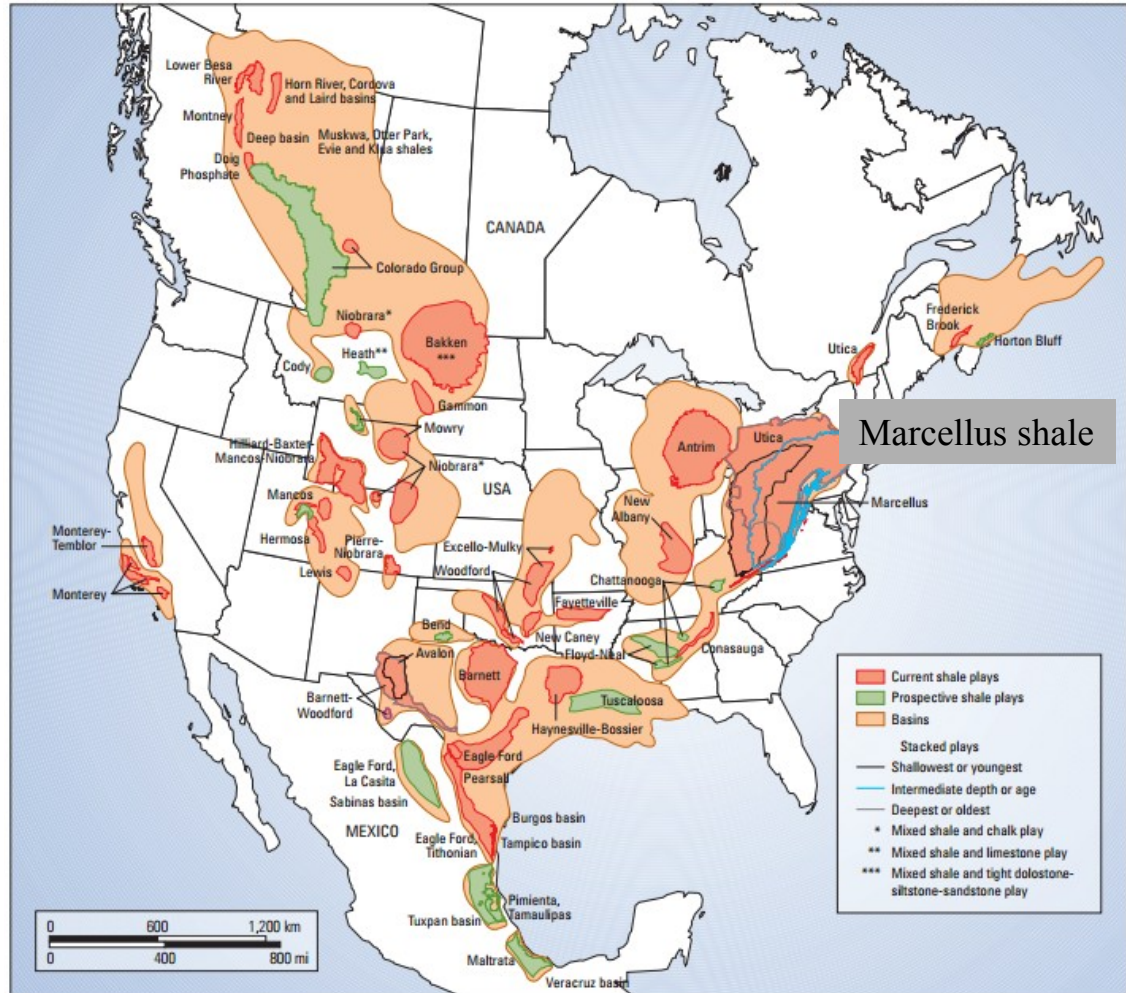
CHINA SHALE GAS DISTRIBUTION

FIG. 1



shale gas - USA

stabilizace cen energií?



^ North America shale plays. (Adapted from Kuuskraa et al, reference 6.)

Další zdroje uhlovodíků

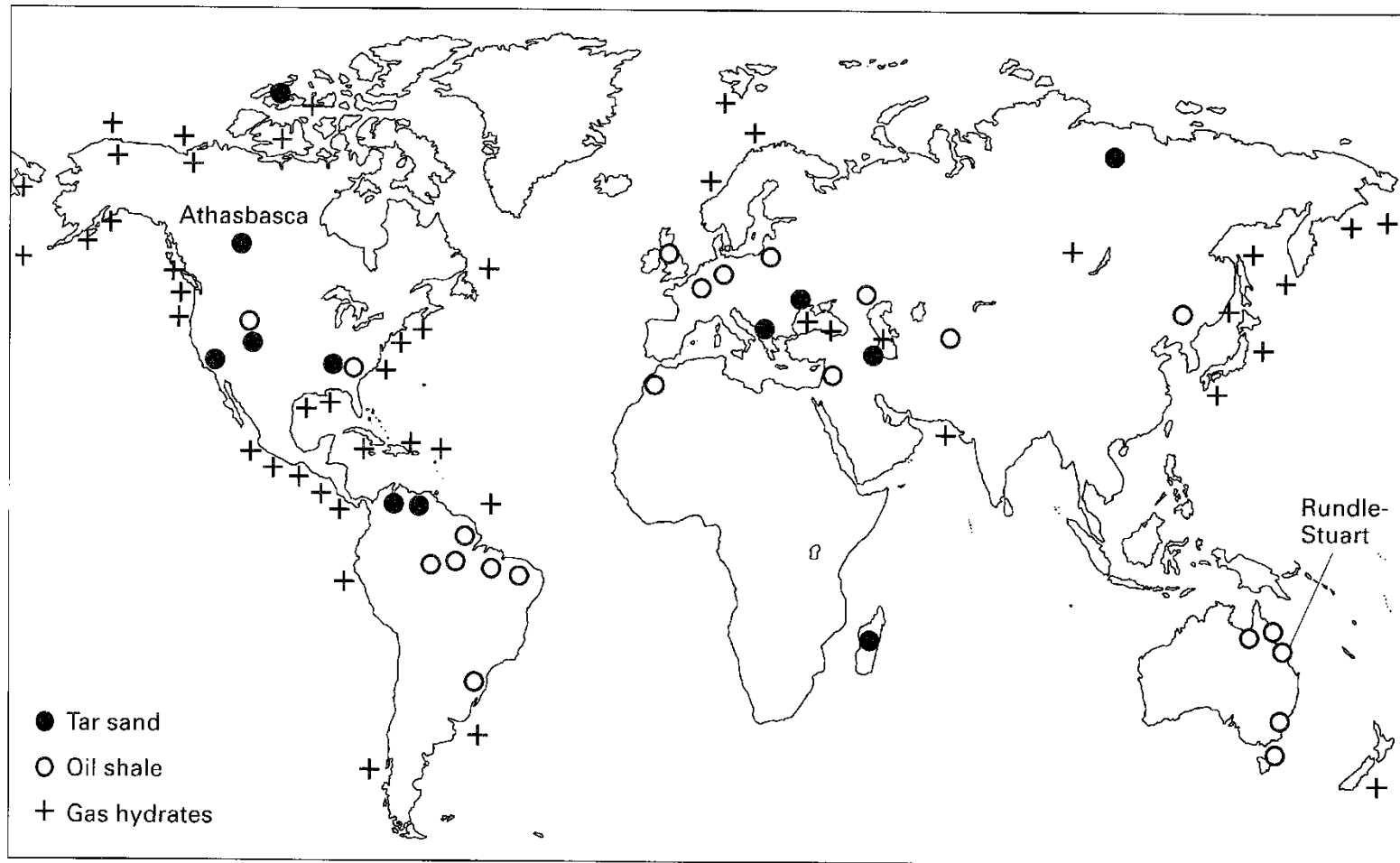
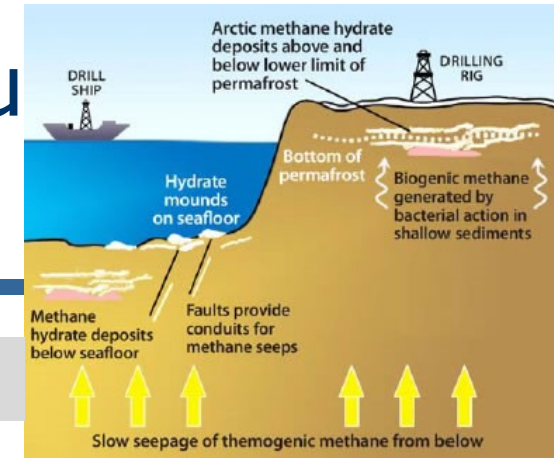
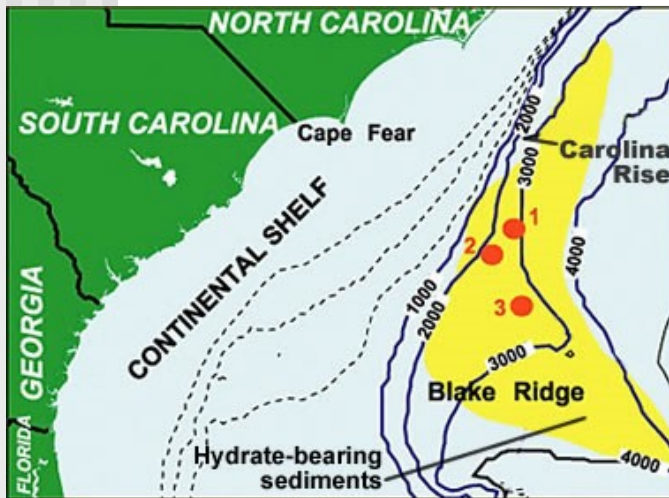


Fig. 25.13 World distribution of important tar sand and oil shale deposits, and the known occurrences of gas hydrates.

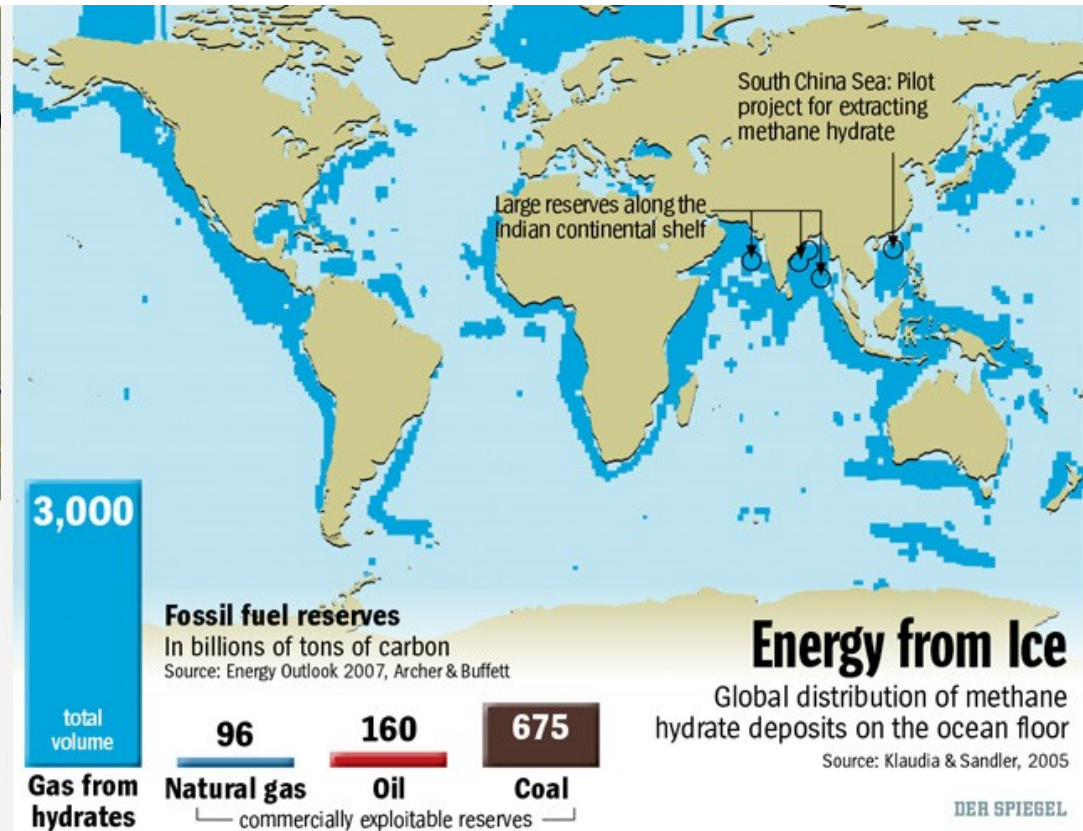
Rozšíření hydrátů metanu



genetic types of gas hydrates



One of the most extensively studied gas hydrate deposits is Blake Ridge, offshore North Carolina and South Carolina. Challenges of producing methane from this deposit are the high clay content and the low methane concentration. [3] This map is an example of the proximity of continental margin deposits to potential natural gas markets. Image by NOAA.



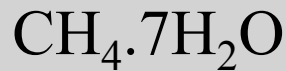
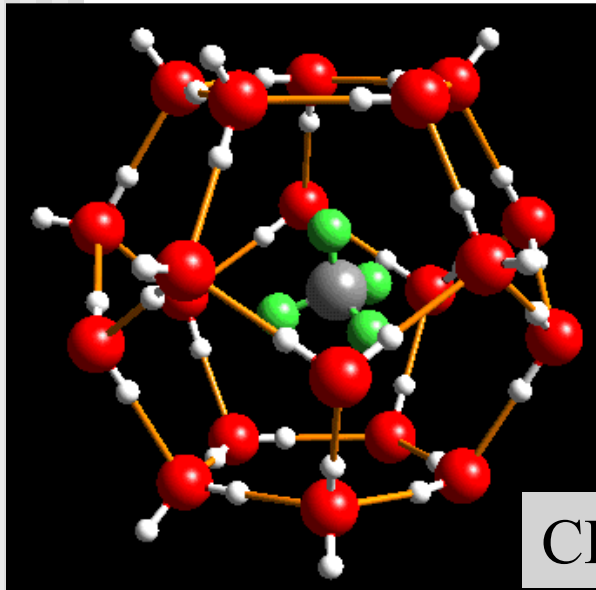
Hydráty metanu I.

- v laboratoři: cca z 1. poloviny 19.stol.
- v přírodě: známo cca ze 60.let 20.stol.

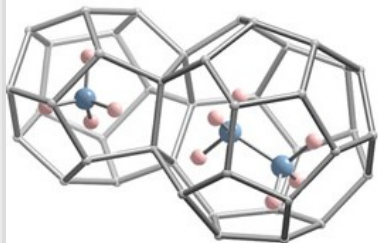
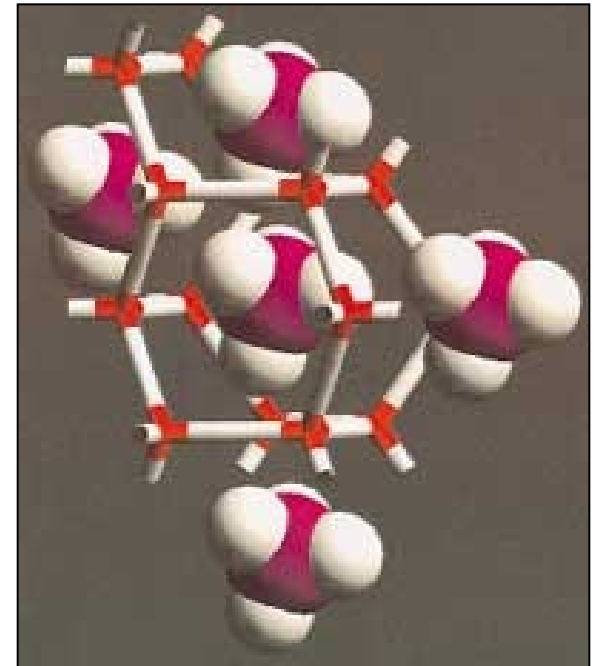
struktura led-metan

Hydráty metanu II.

Van der Waalsovy síly



slabší než vodíkové
můstky,
vzájemné působení
molekulových dipólů



Example of
methane-
ethane
double
hydrate (only
2 cages are
shown)

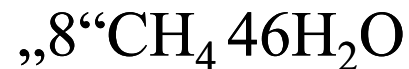


Image courtesy Southwest
Research Institute.

Jak vypadají makroskopicky?



A Hester KC, Brewer PG. 2009.
R Annu. Rev. Mar. Sci. 1:303–27

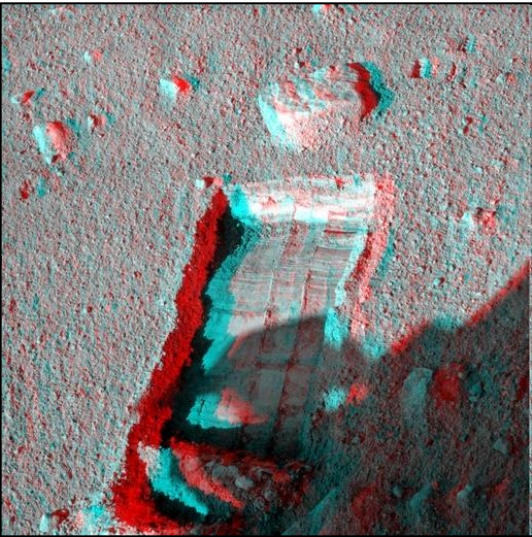
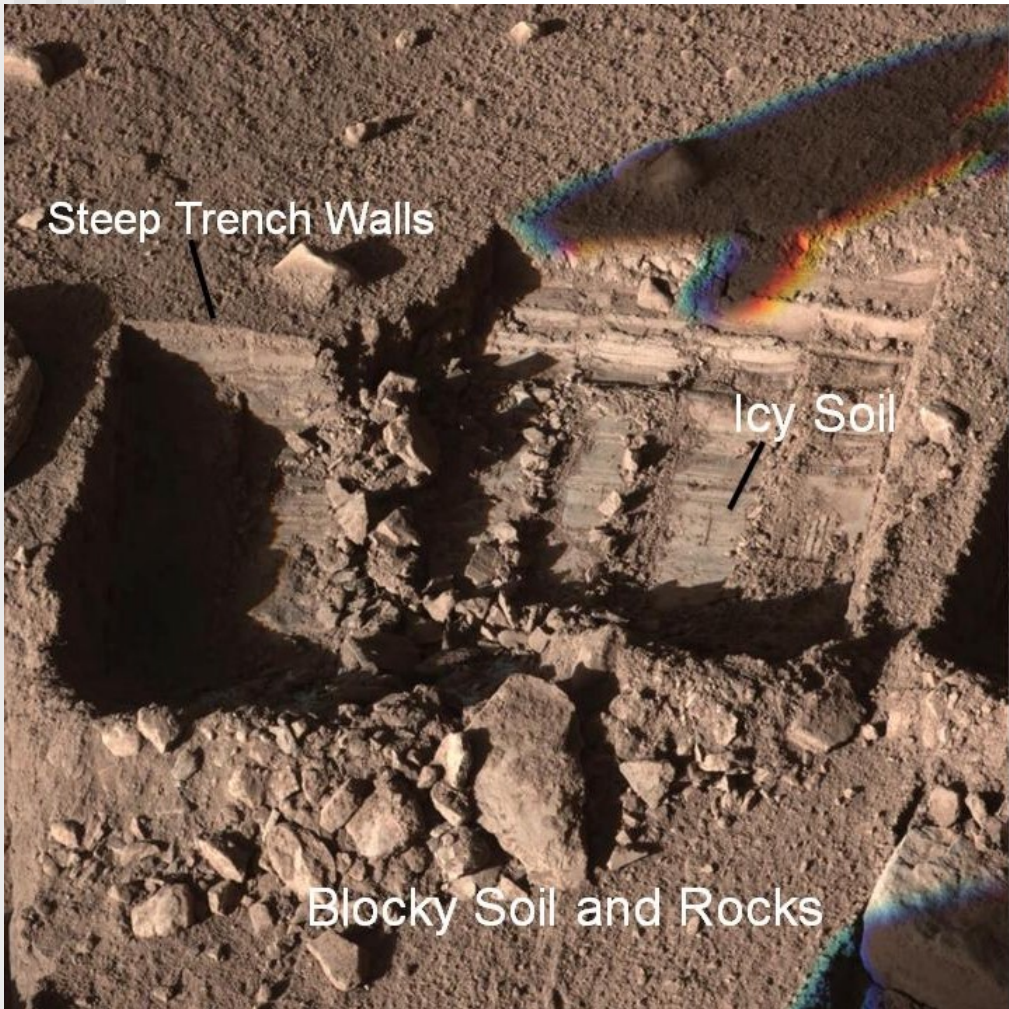


A close-up of methane hydrate observed at a depth of 3,460 feet (1,055 meters) off the U.S. Atlantic Coast. NOAA Okeanos Explorer Program/2013 Northeast U.S. Canyons Expedition.

Důsledky složení a struktury



Mars



Sol 148 View

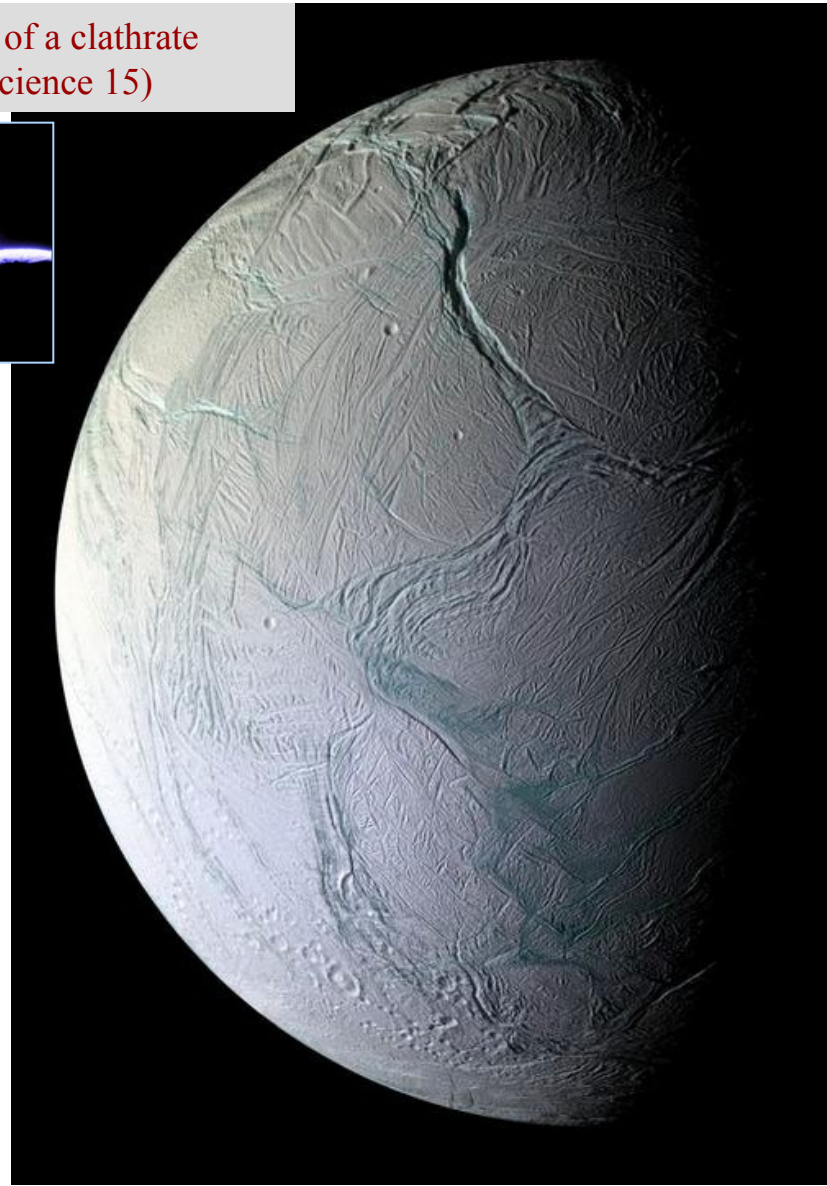
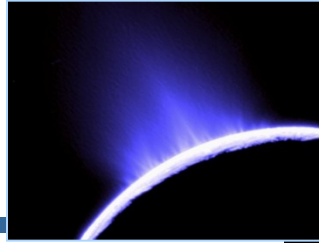
LaMancha Trench

Icy soil few cm
beneath blocky soil

Blocky Soil and Rocks

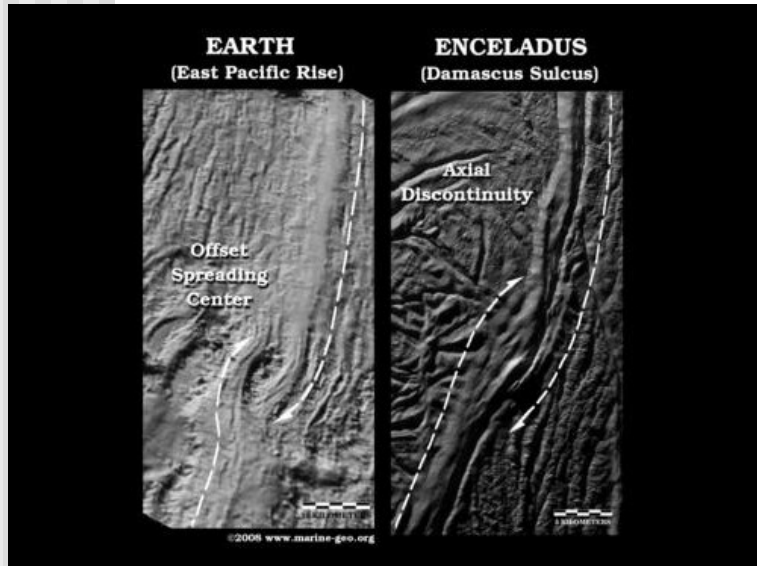
... fractures that cause degassing of a clathrate reservoir ... (Susan et al. 2006, Science 15)

Enceladus



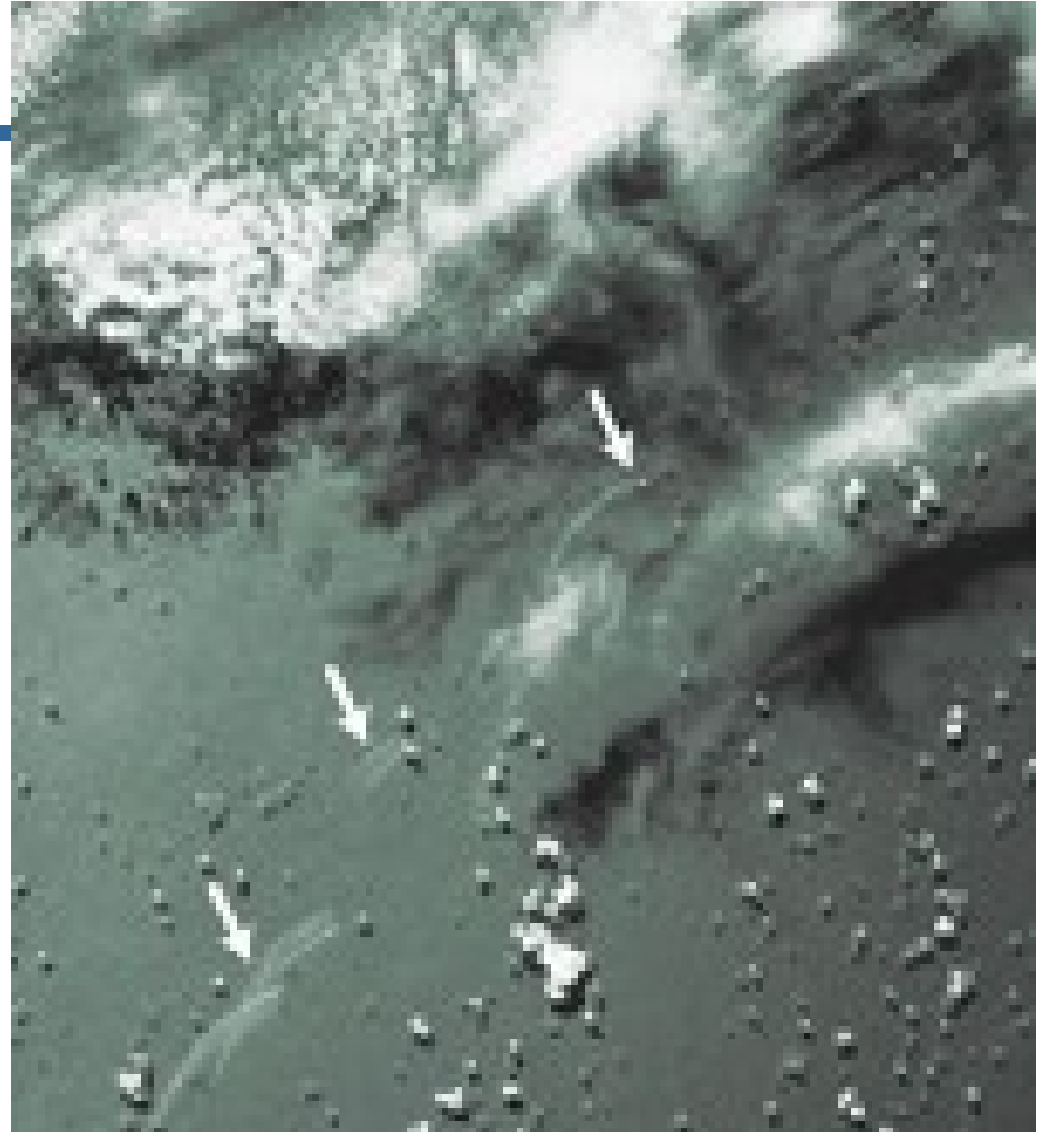
Enceladus in Eclipse
January 7, 2009

The image was taken in visible light with the Cassini spacecraft narrow-angle camera on Oct. 31, 2008 at a distance of approximately 137,000 kilometers (85,100 miles) from Enceladus (moon of Saturn)



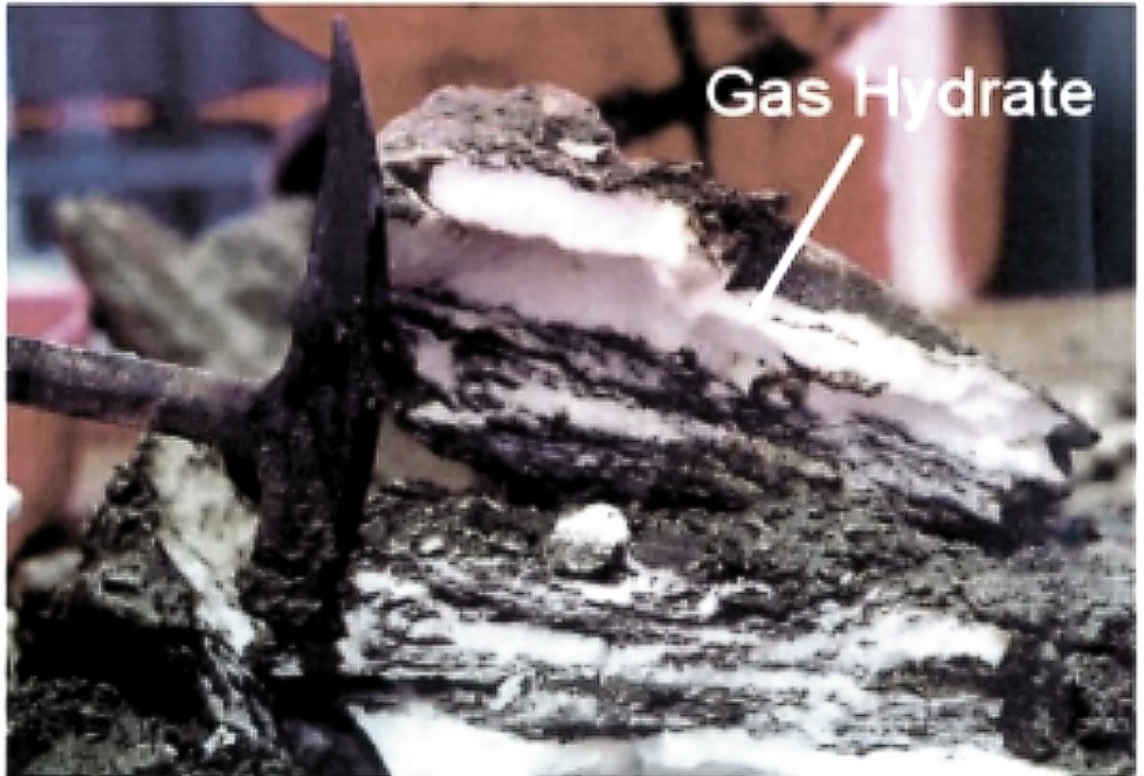
Enceladus Offset Spreading Center
December 15, 2008

I na Zemi - uvolňování metanu

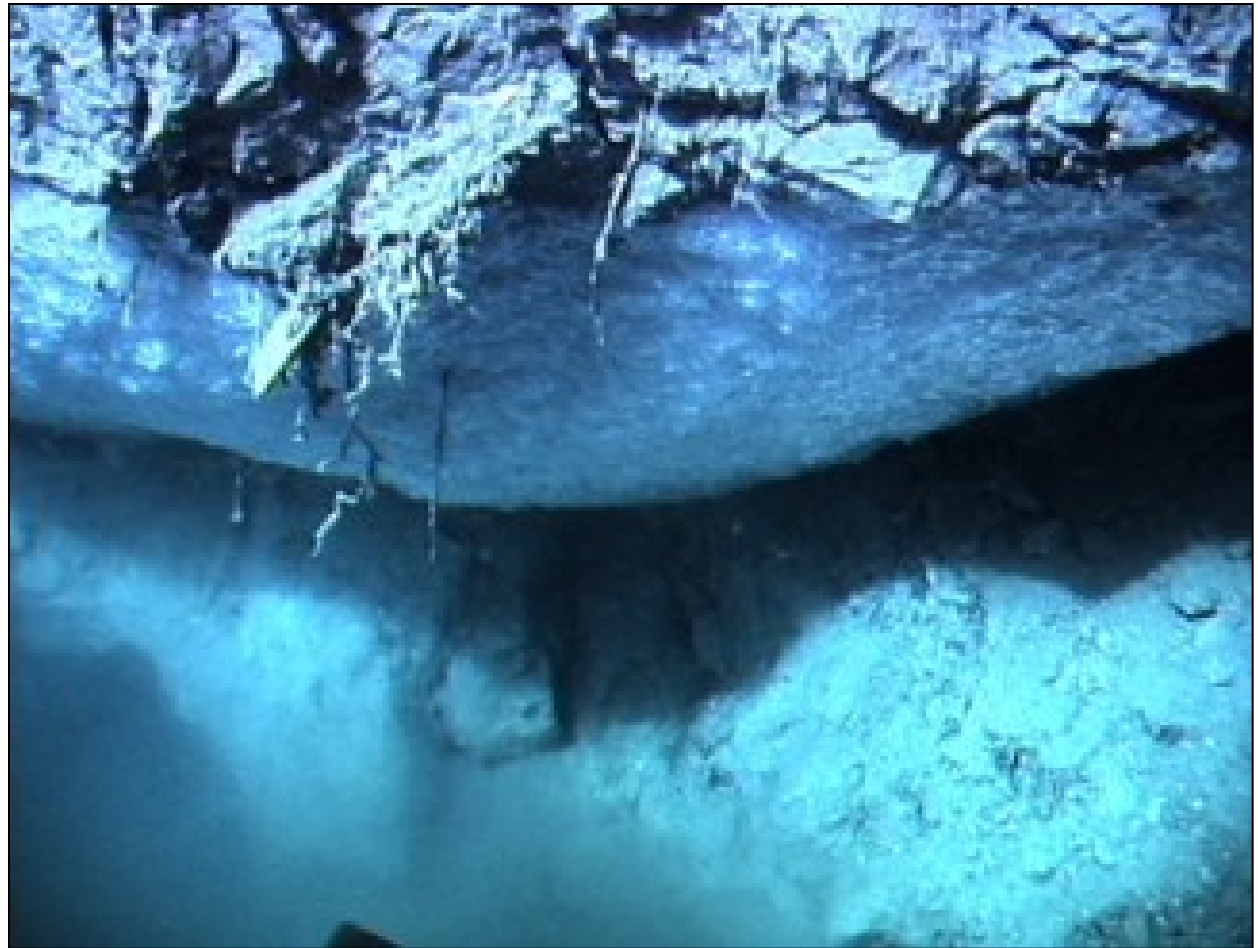


This colorized image of the ocean surface taken from the space shuttle makes the sea and clouds look like an artist's abstract dabs and brushstrokes. The bright streaks are oil slicks produced by hydrocarbons seeping naturally from seafloor vents.

Vrstvičky hydrátů metanu



Vrstvy hydrátů



In 2001, researchers using the submersible Alvin photographed hydrate forming under a rock overhang near Blake Ridge, offshore of Georgia, at a site where the Ocean Drilling Project drilled in 1995. Image courtesy of Woods Hole Oceanographic Institution.

Vznik metanu (hydrátů)



Methane is produced in reaction 4 by fermentation and in reaction 5 by carbonate reduction. The CO_2 required in reaction 5 is produced in reactions (1) to (4). The methane produced freezes in the sea water to form methane hydrate and is deposited in the space between grains of ocean sediment as cement.

Thermogenic alteration occurs when sediments containing organic carbon are deeply buried within a sedimentary basin resulting in elevated temperatures. When the temperature reaches $\sim 100^\circ\text{C}$, the organic carbon breaks down to form methane (CH_4) and carbon-dioxide (CO_2). Methane formed by thermogenic alteration percolates up through the sedimentary pile and combines with water to form the methane hydrate.

Formation of Gas Hydrate in marine environments

In nature organic carbon from the detrital remains of dead organisms is converted into methane in two ways, biogenically (bacteria) and thermogenically (heat). Bacteria that live in marine sediments survive by consuming organic carbon from the dead biota deposited with the sediment. This bacterial activity occurs in the top 10's of meters of the ocean floor. The main reactions used by different bacteria are (1) bacterial oxidation, (2 & 3) bacterial sulphate reduction, (4) bacterial fermentation and (5) bacterial carbonate reduction:



Methane is produced in reaction 4 by fermentation and in reaction 5 by carbonate **reduction**. The CO_2 required in reaction 5 is produced in reactions (1) to (4). The methane produced freezes in the sea water to form methane hydrate and is deposited in the space between grains of ocean sediment as cement.

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Stabilita fází systému H_2O-CH_4

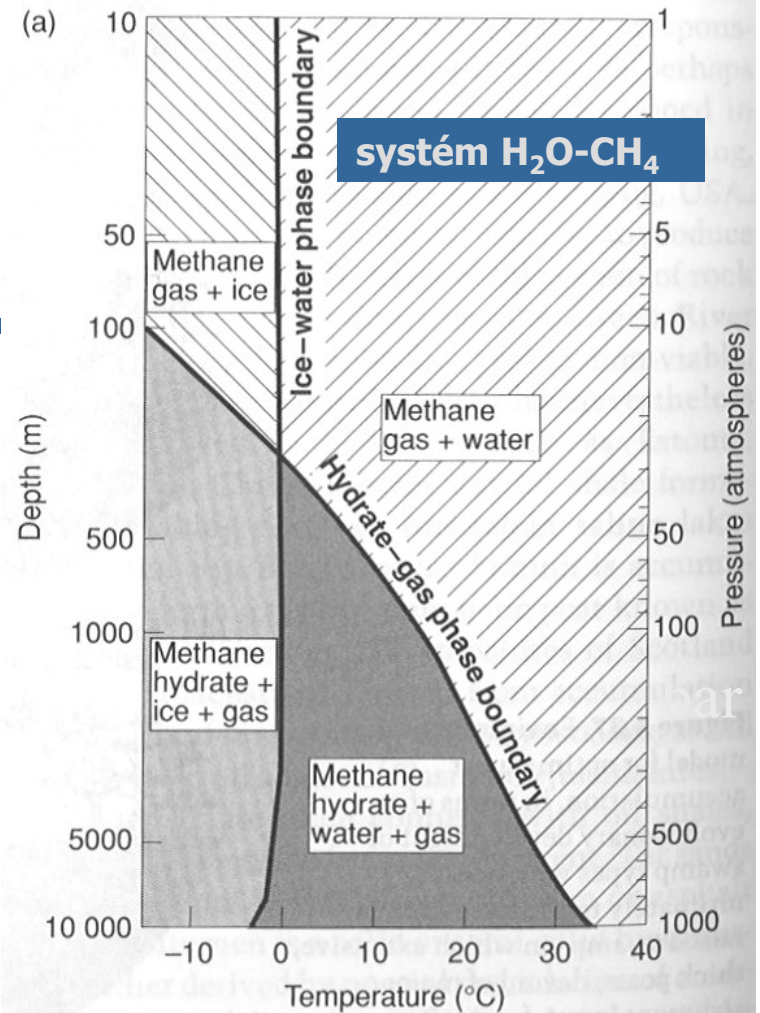
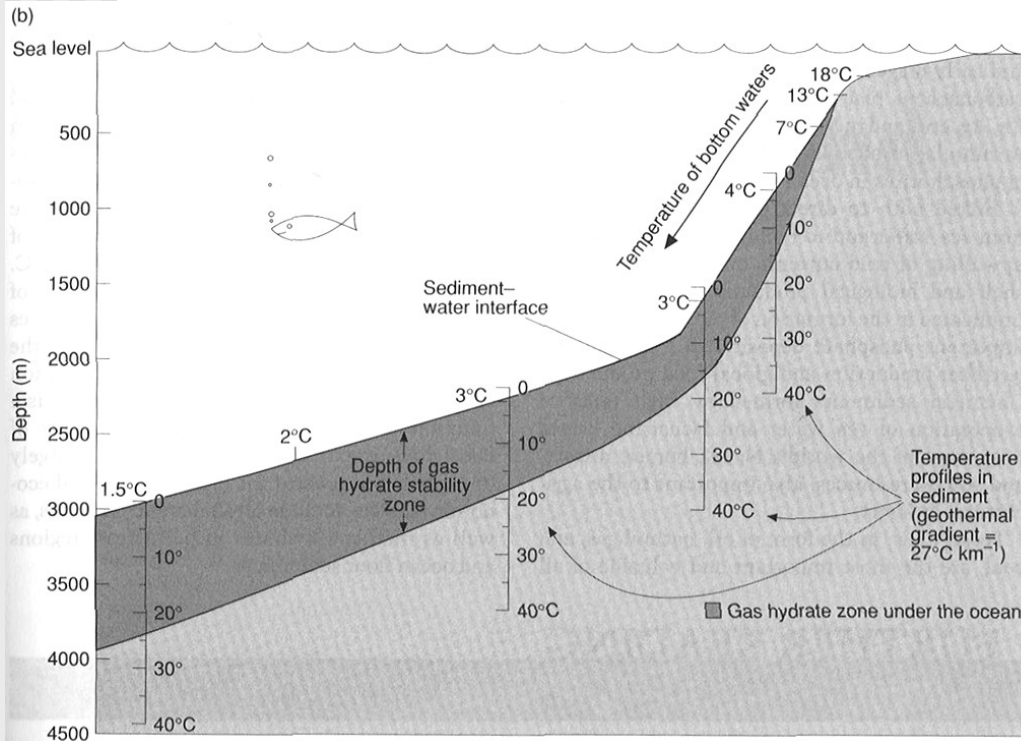
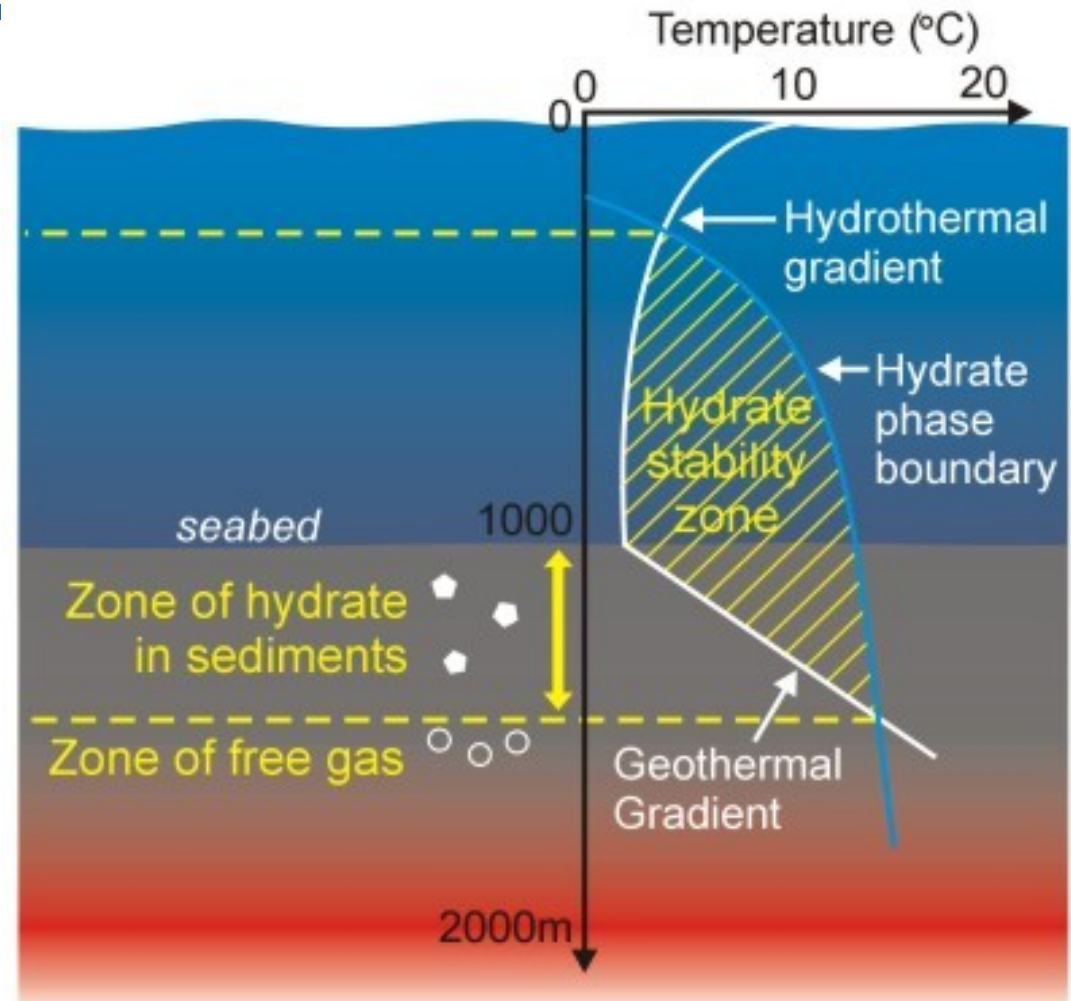


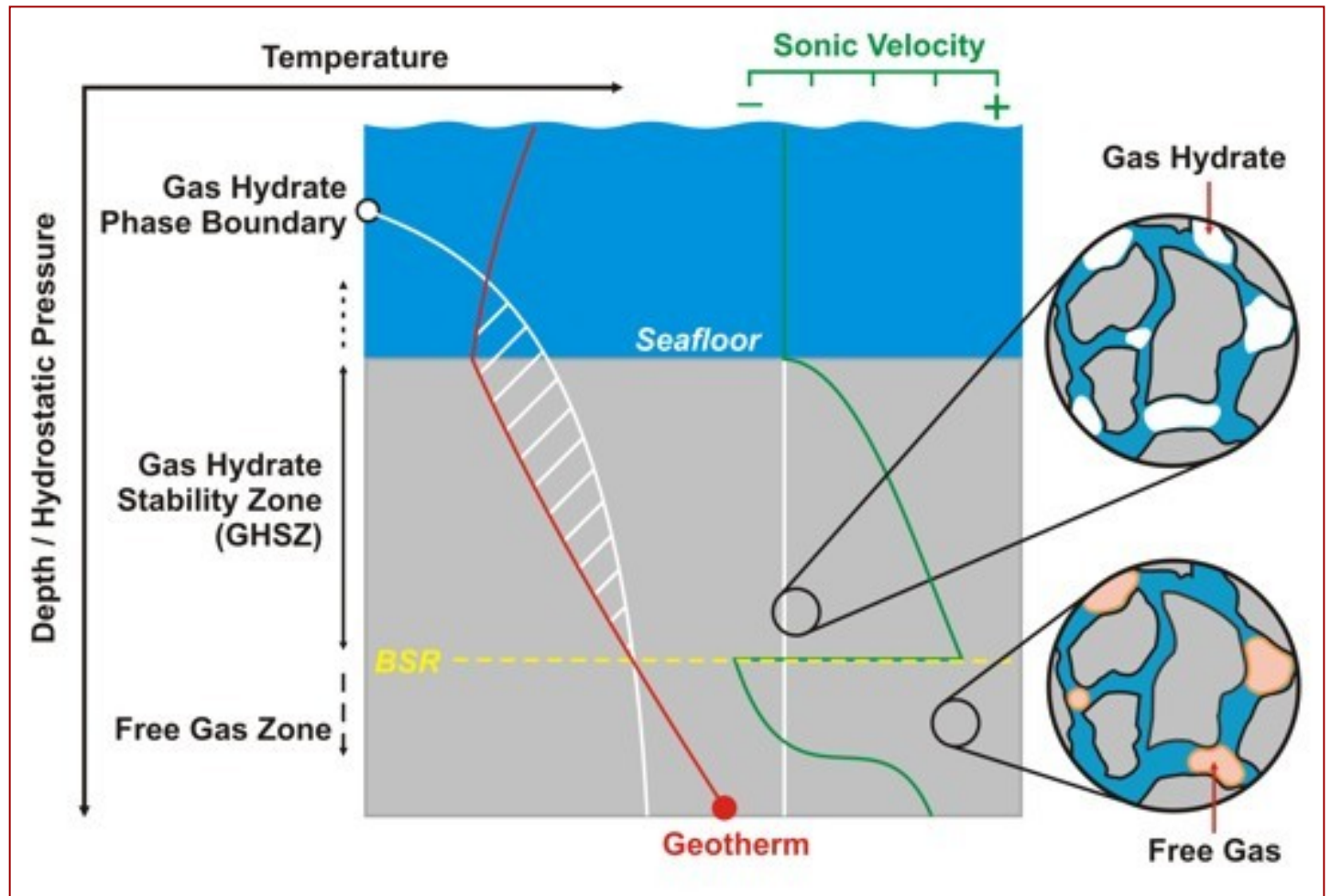
Figure 5.38 (a) Phase diagram illustrating the regions of gas hydrate stability under most natural conditions in the near-surface (after Kvenvolden and McMenamin, 1980). (b) Profile across a typical ocean-sediment interface in a continental margin setting, showing the progressive increase in the width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

Stabilita hydrátů CH₄



The Hydrate Stability Zone in Subsea Sediments

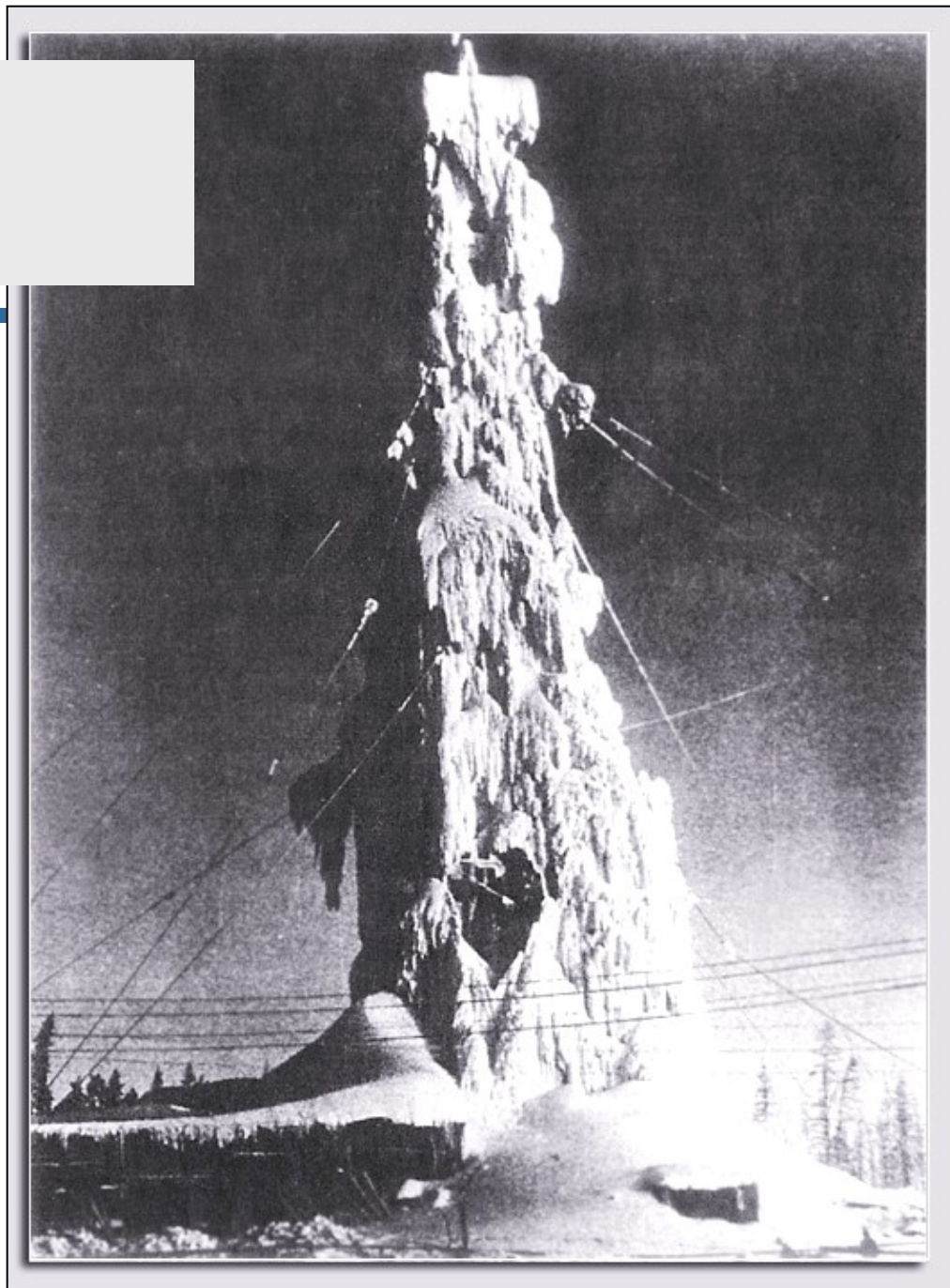
Hydráty v mořských sedimentech



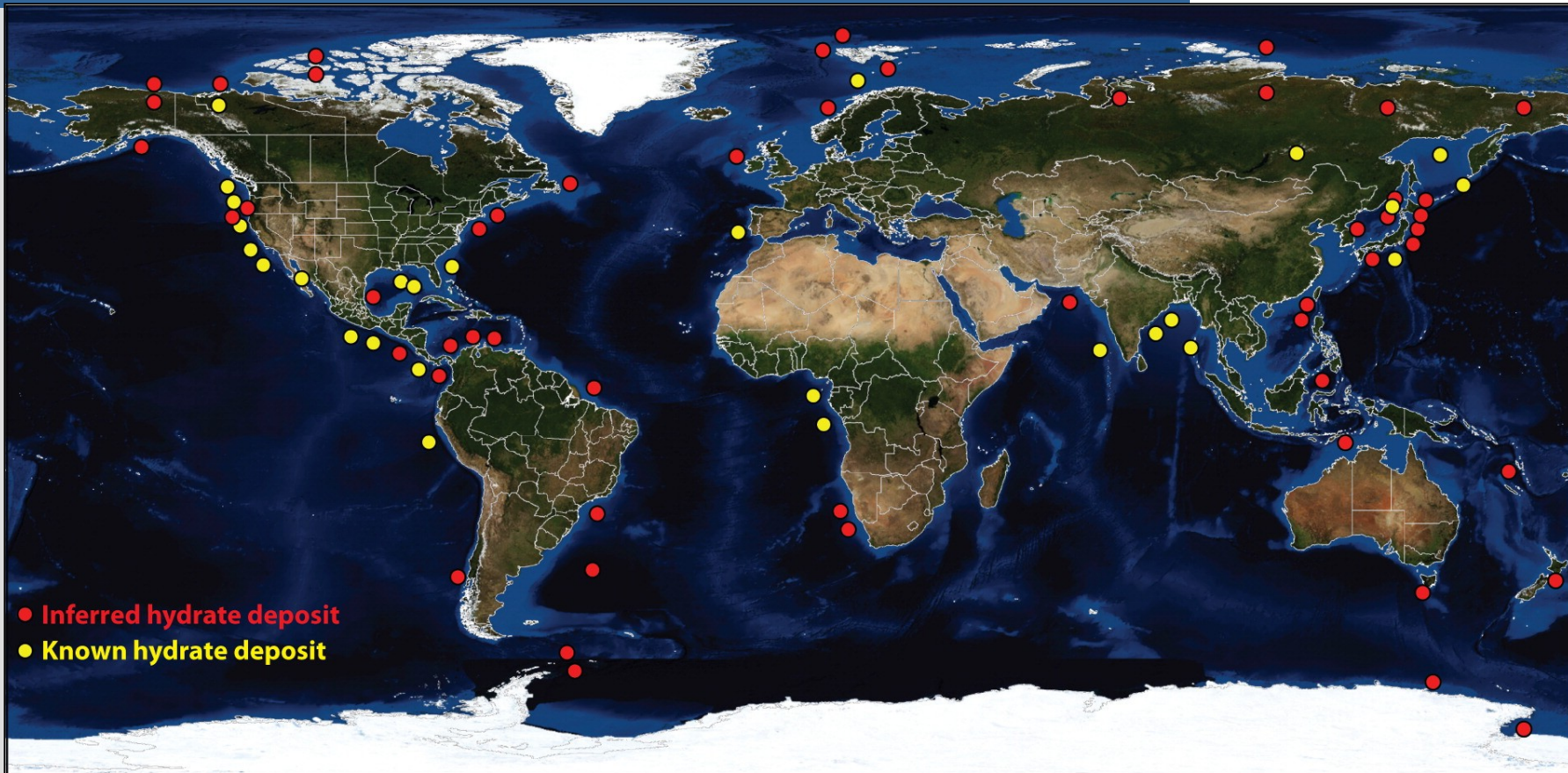
Hydráty - Sibiř

*A huge pillar of solidified (natural) gas hydrate produced in a methane pipeline rupture under below-zero (-63°C) conditions; the height of the pillar can be estimated, by comparison with the hut, as about 60 m. The photograph was taken in Siberia by Novosti Press Agency and is reproduced from Makogon (1987).

Frank H. Herbstein, Crystalline Molecular Complexes and Compounds, Oxford Univ. Press, 2005



Průzkum a prognózy



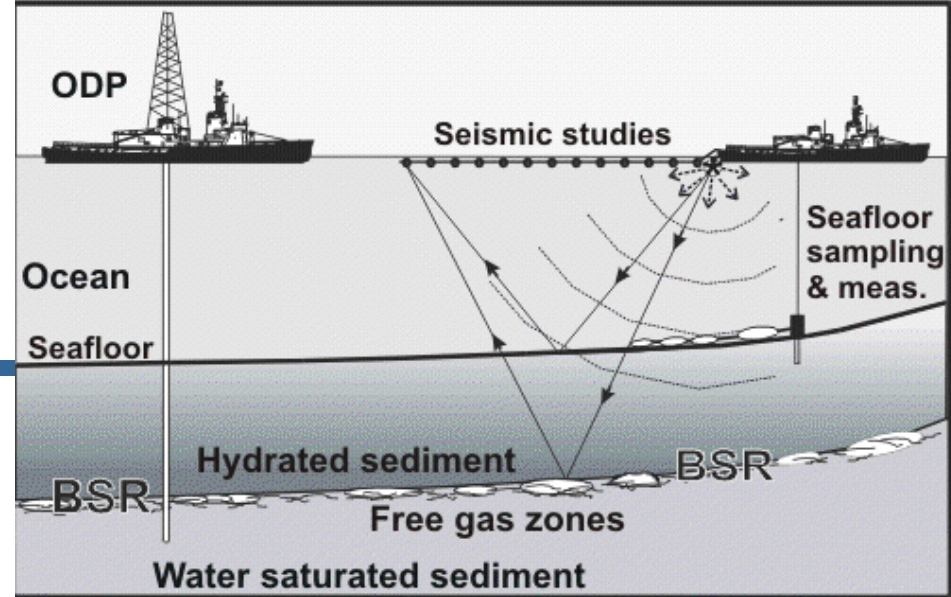
Zdroje hydrátů v číslech

Table 2 Conventional and hydrated gas resources in trillion cubic metres

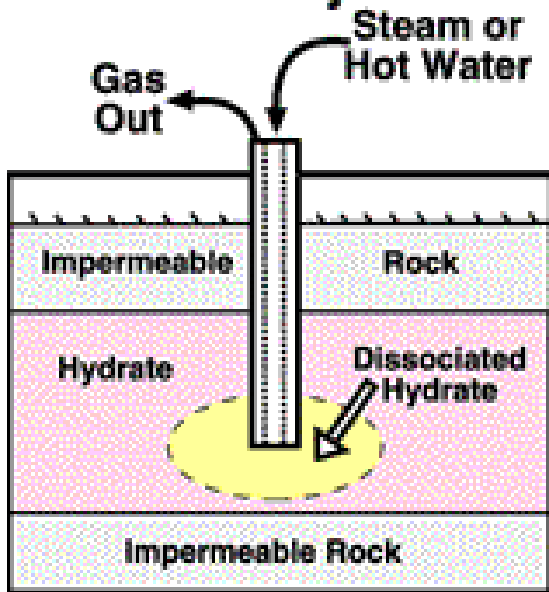
Region	Conventional gas (TCM)	Methanehydrate (TCM)
North America	32.82	6,853
Latin America and Caribbean	21.1	5,139
Western Europe	15.27	856
Central and Eastern Europe	2.05	0
Former Soviet Union	117	4,711
Middle East and North Africa	77.2	214
Sub-Saharan Africa	13.9	429
Central Asia and China	10.07	429
Pacific OECD	2.68	1,713
Other Pacific Asia	11.18	214
South Asia	4.72	429
Total	310.3	20,987

TCM, trillion cubic metres

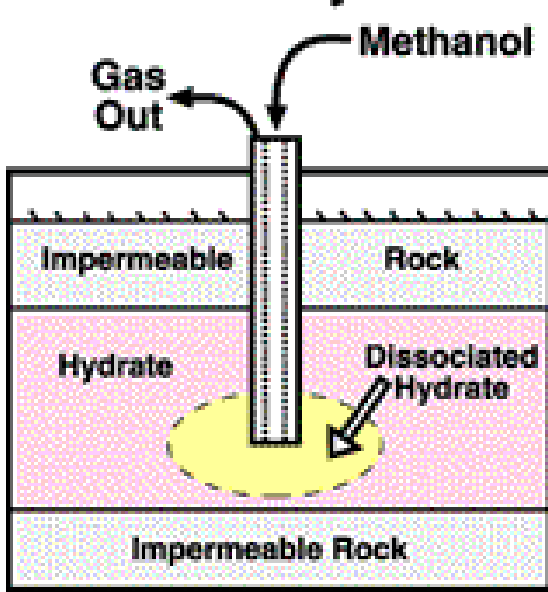
Průzkum a těžba



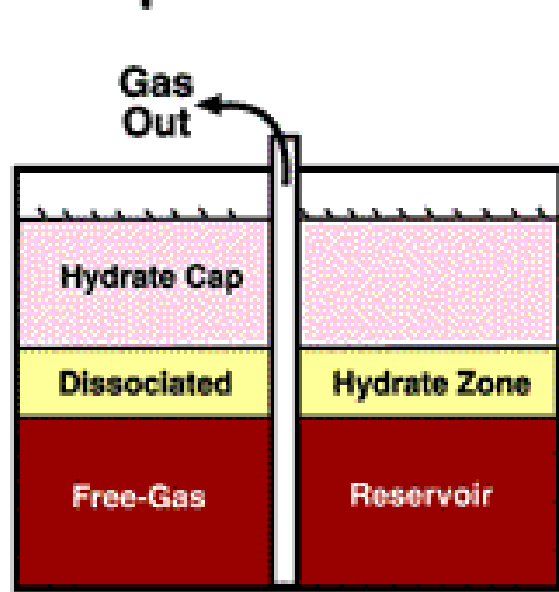
Thermal Injection



Inhibitor Injection

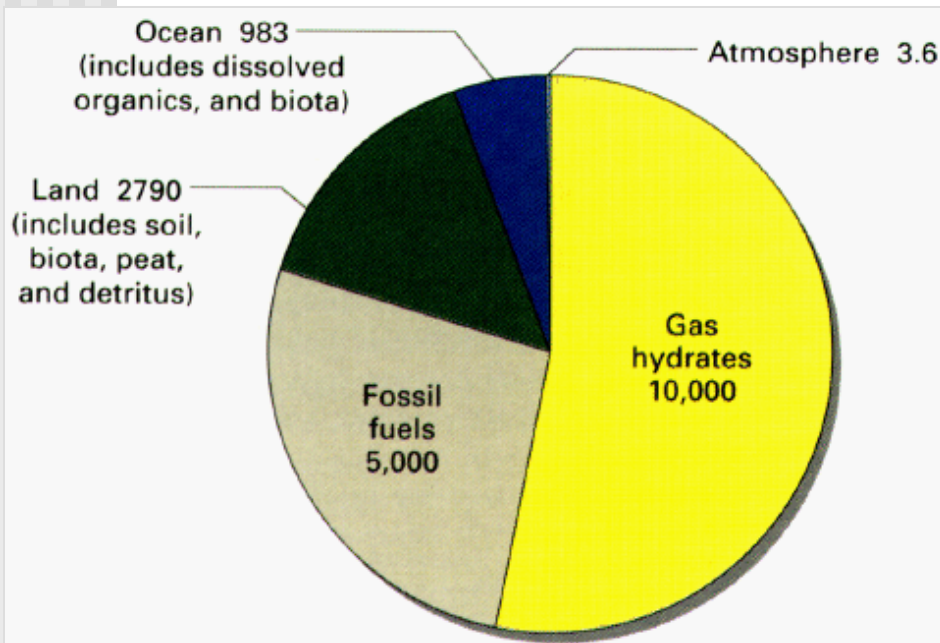


Depressurization

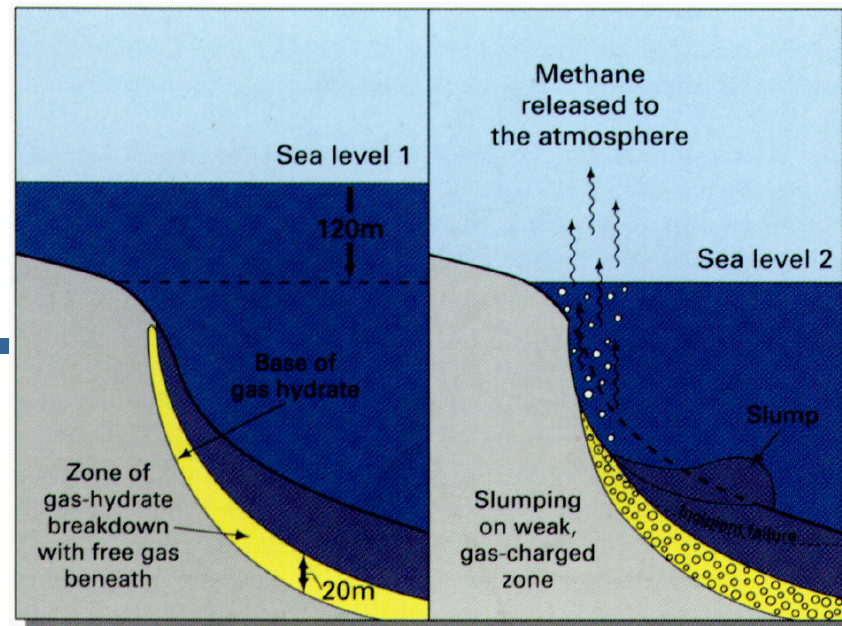


Význam hydrátů metanu

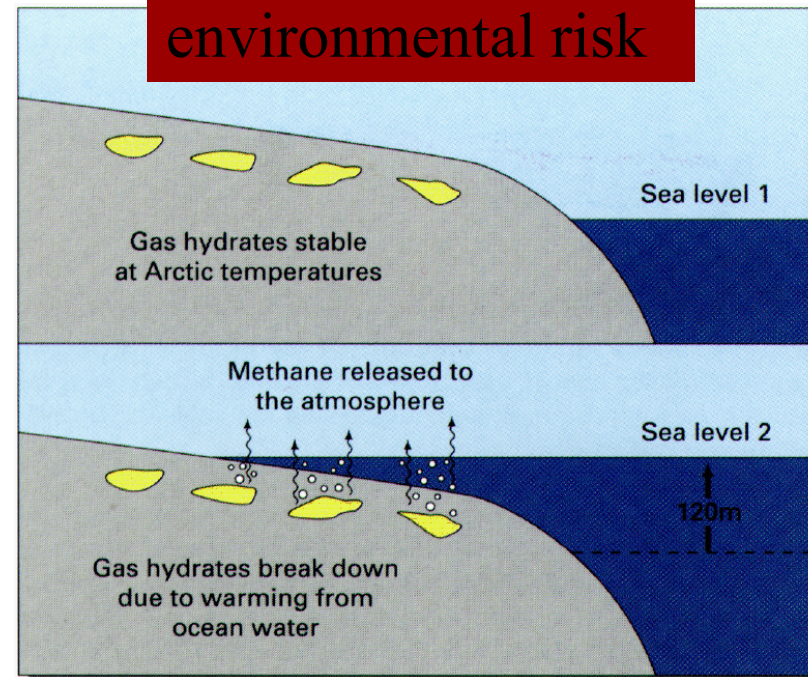
fossil fuels reserves



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.



environmental risk



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.