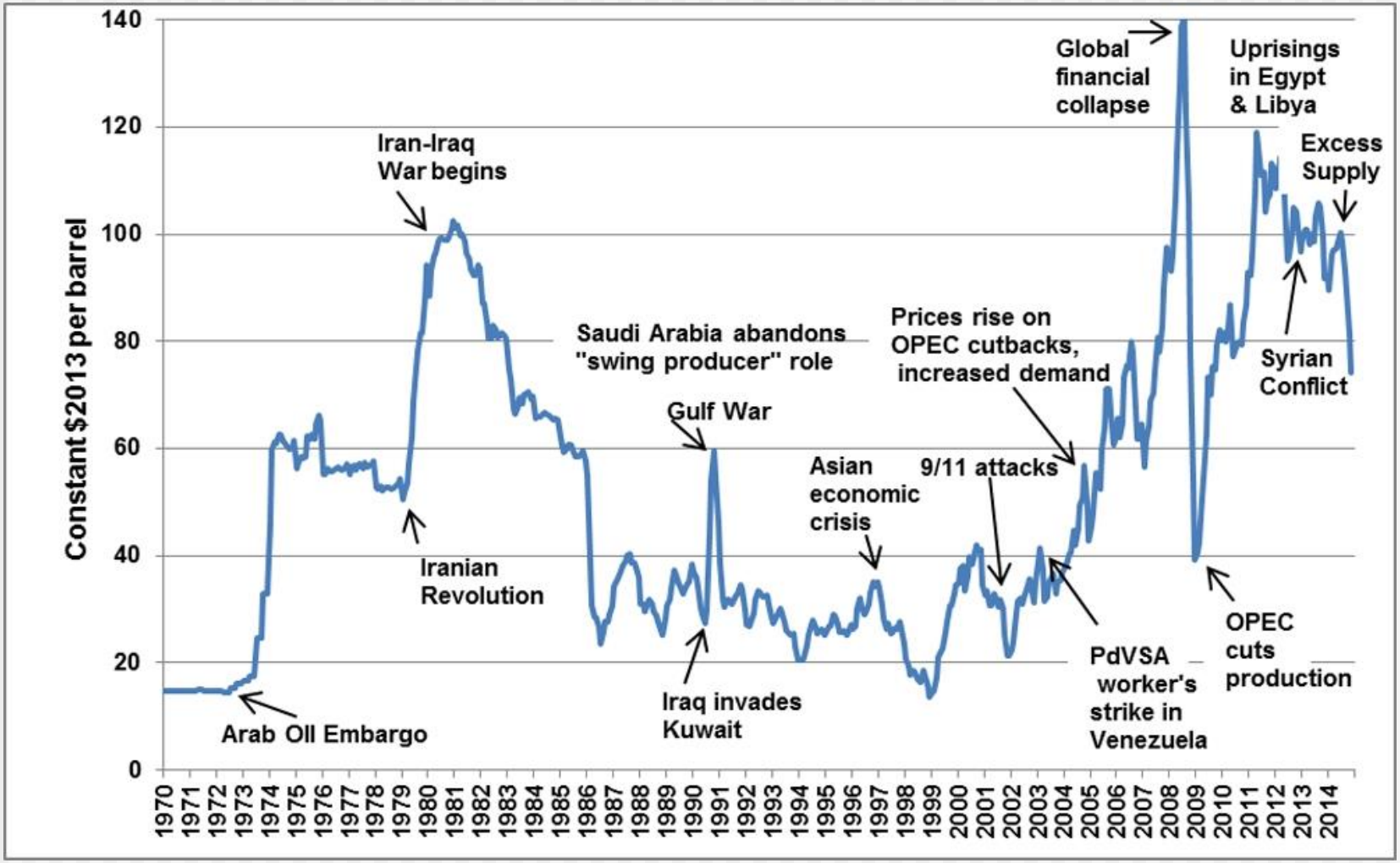
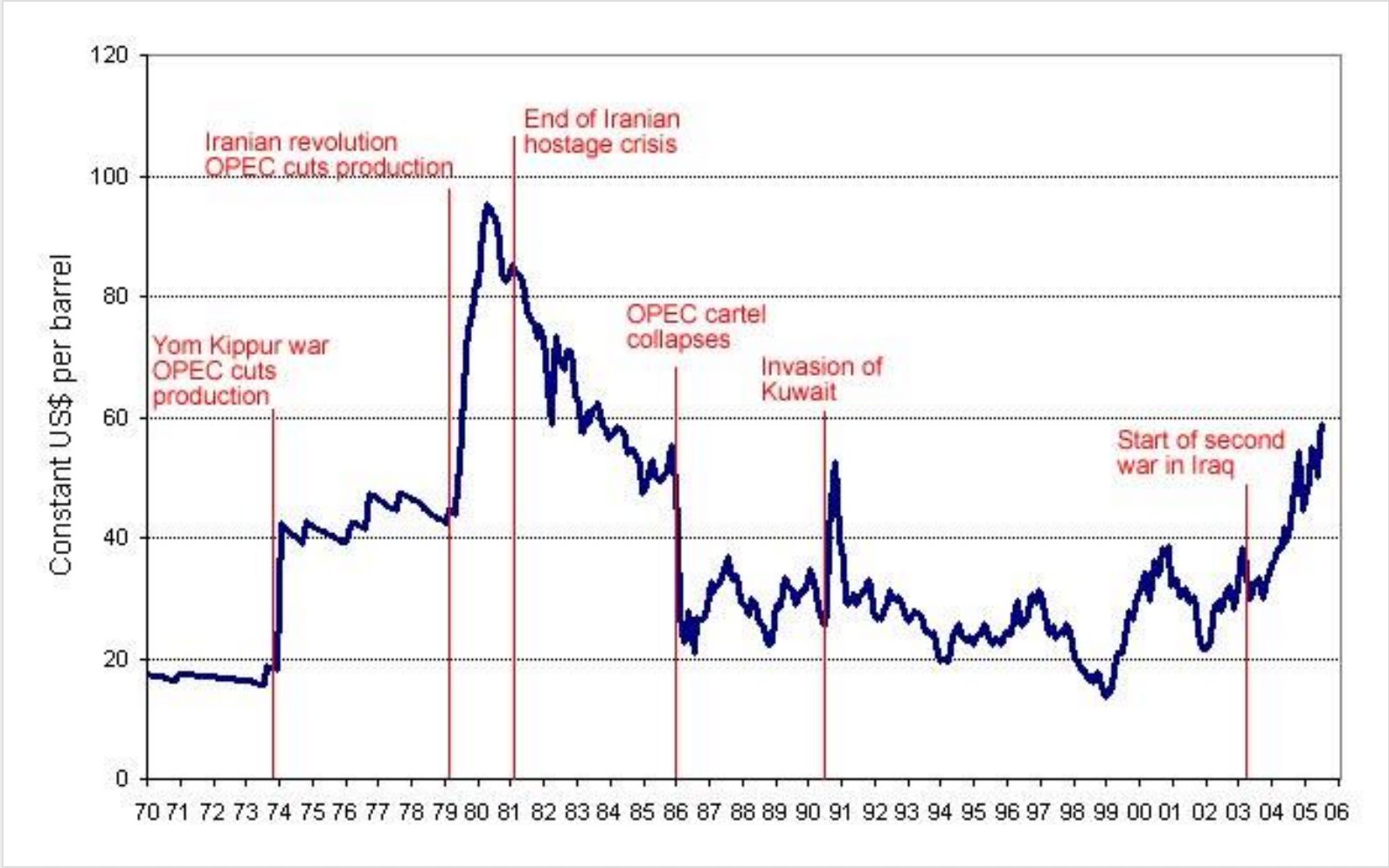
Energetické suroviny

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

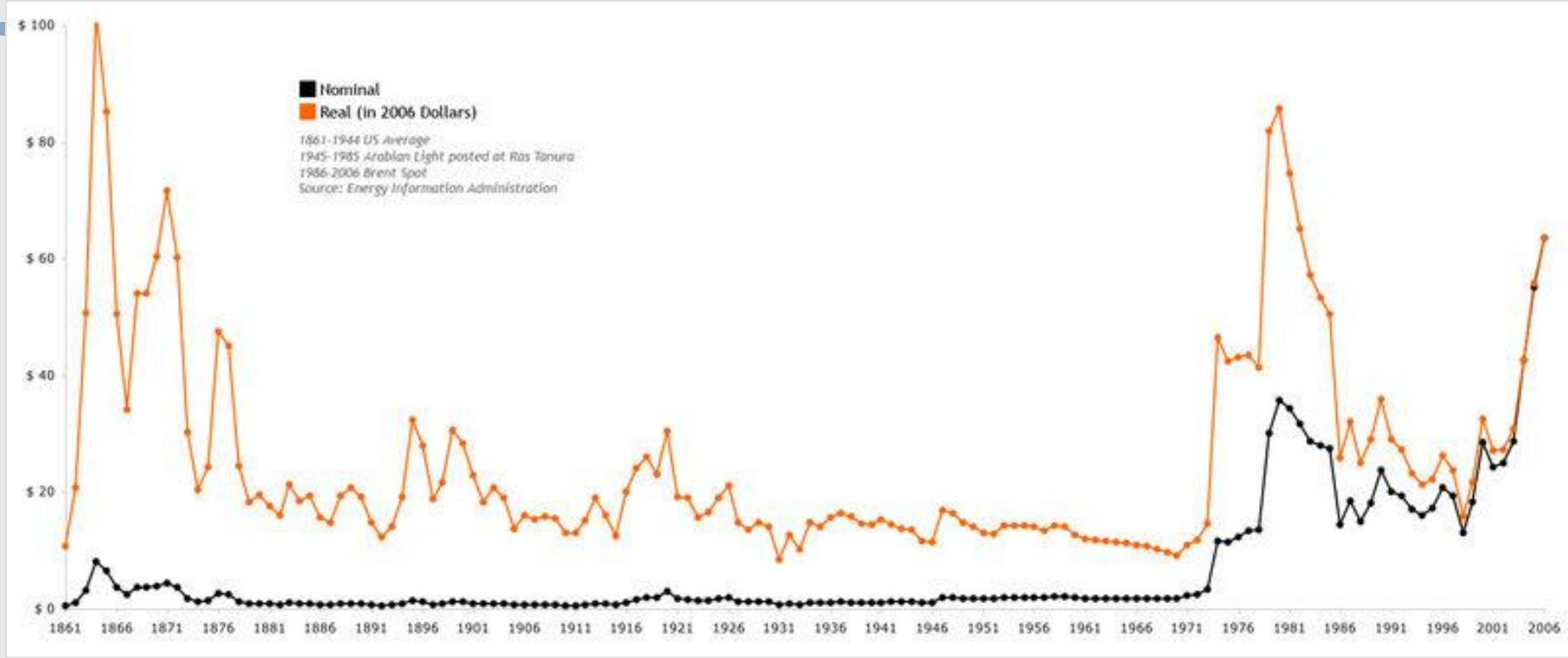
Ropa – strategická surovina



Ceny a mezinárodní konflikty

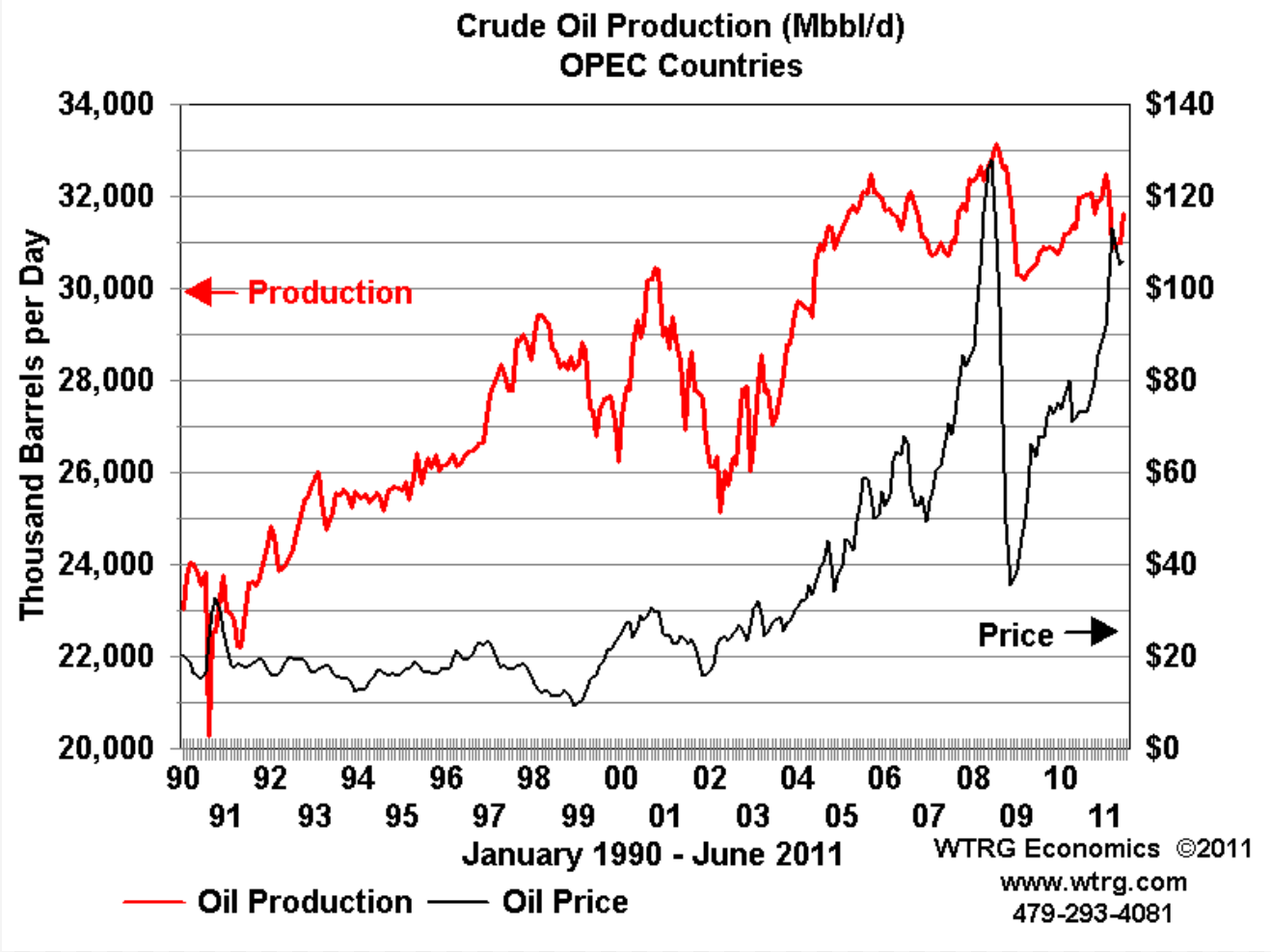


Historie cen ropy

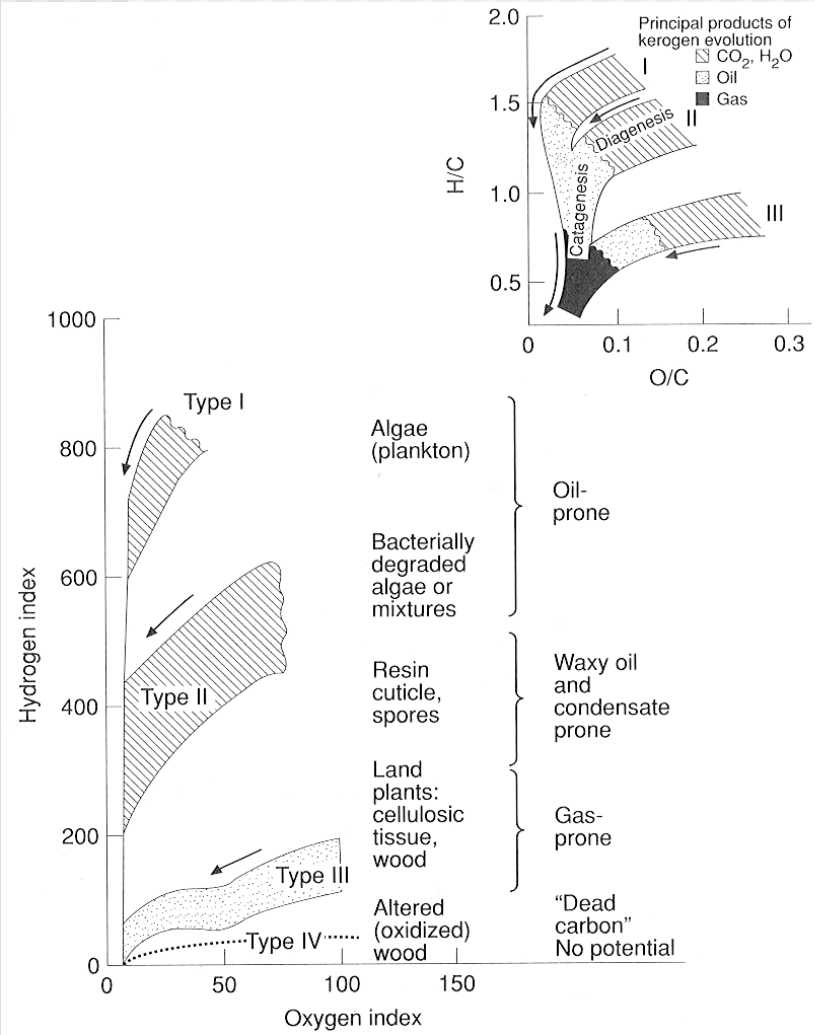


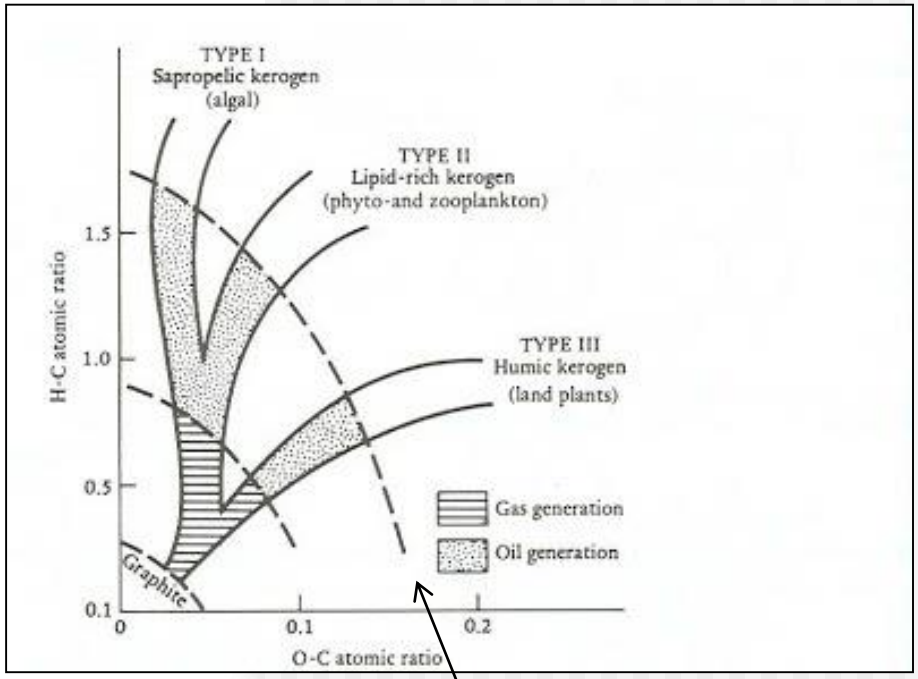
http://www.wtrg.com/prices.htm

Produkce - cena



Geneze kerogenu





vznik geopolymerů a krakování

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).

(Robb 2005)

Vznik uhlovodíků

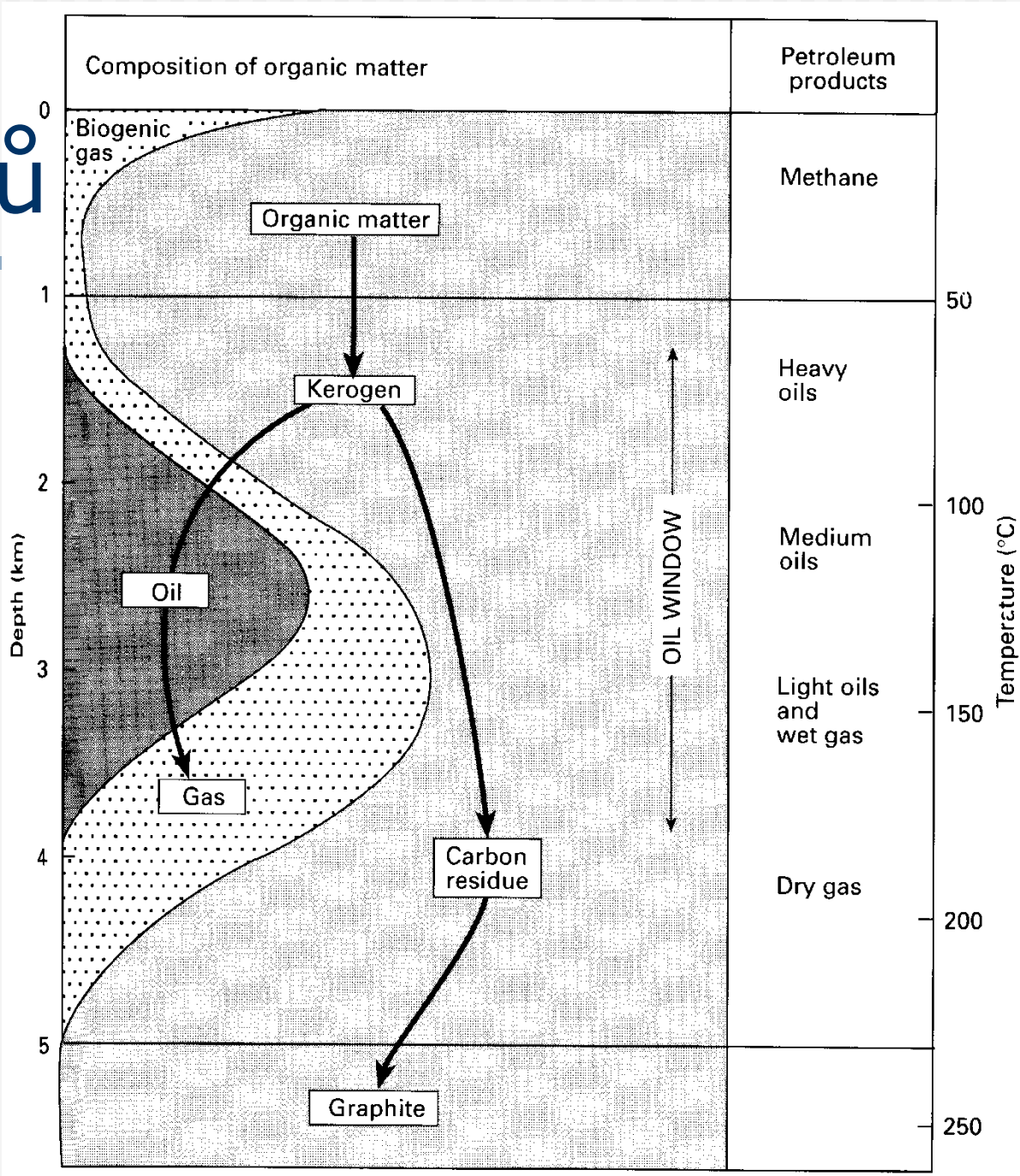


Fig. 25.5 Organic matter diagenesis showing the relationship between temperature, depth of burial and the petroleum products formed.

Ropa - oblasti

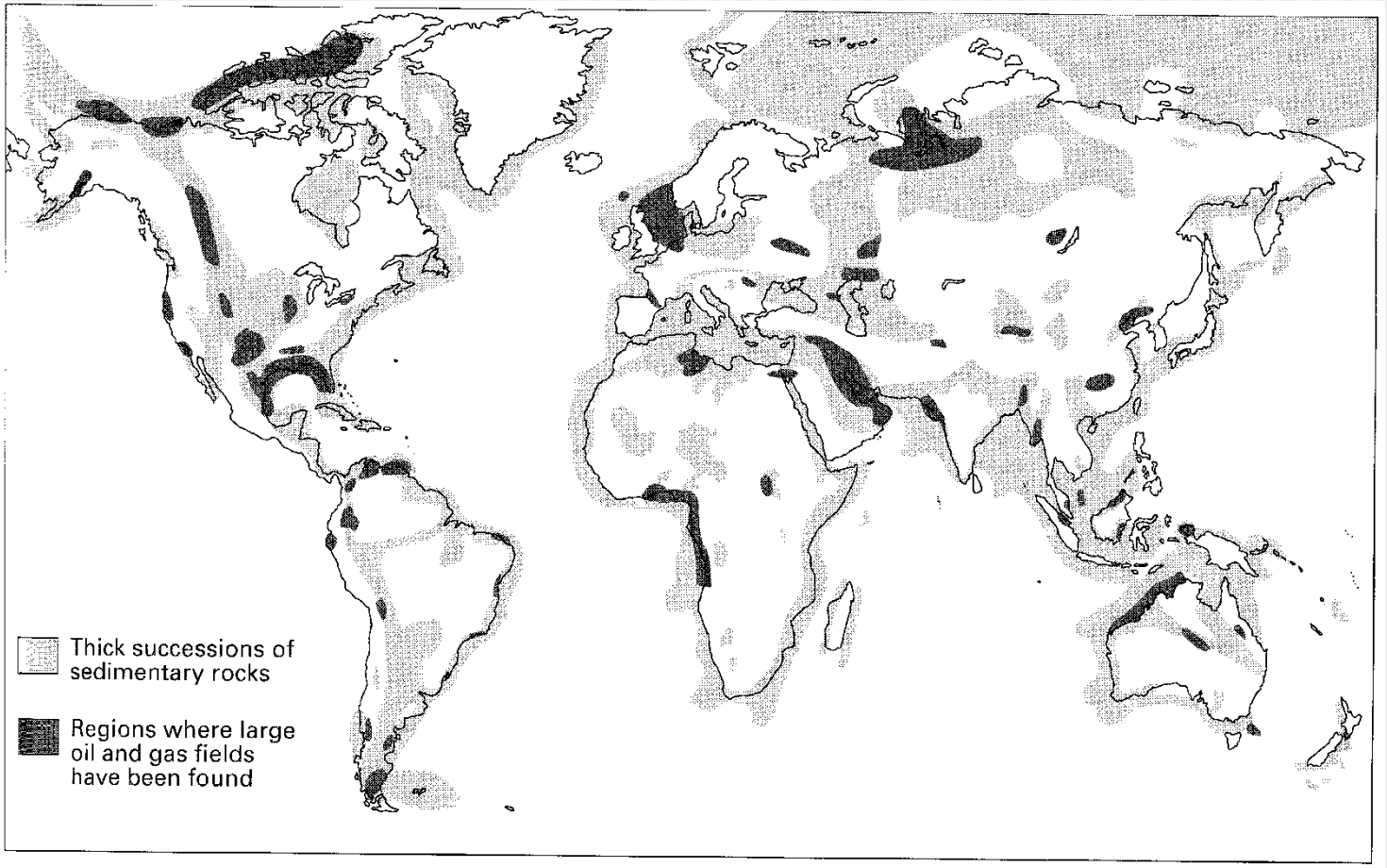
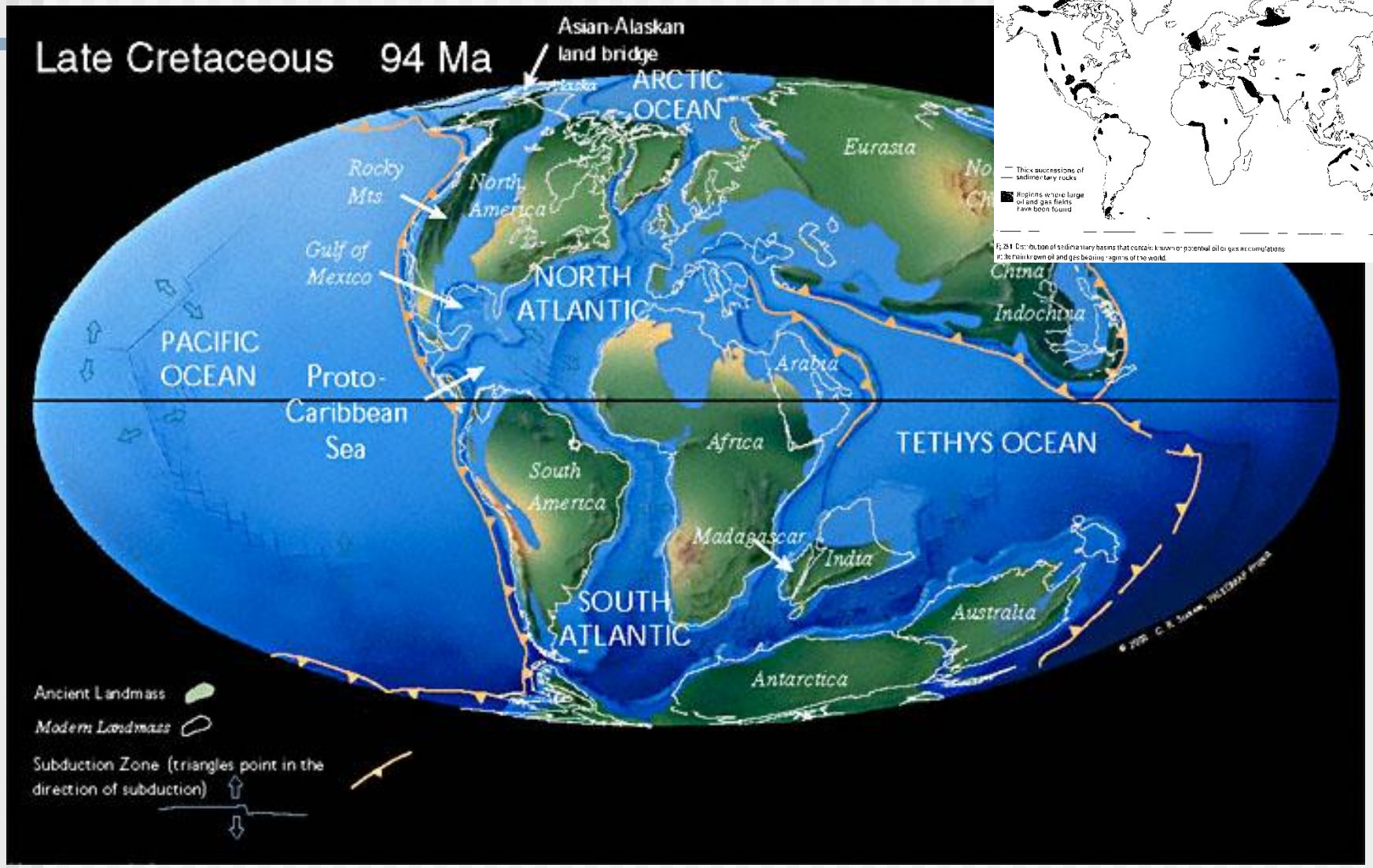


Fig. 25.1 Distribution of sedimentary basins that contain known or potential oil or gas accumulations and the main known oil and gas bearing regions of the world.

Vznik uhlovodíků - paleogeografie



Ropné pasti - ložiska

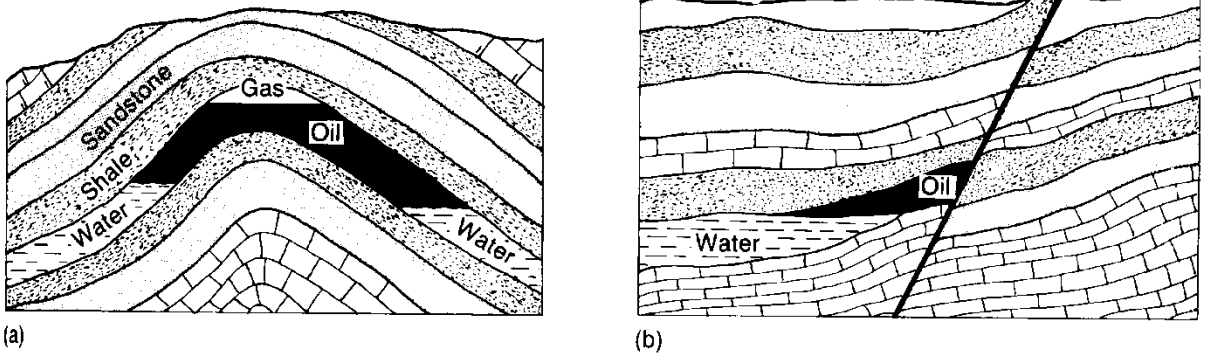
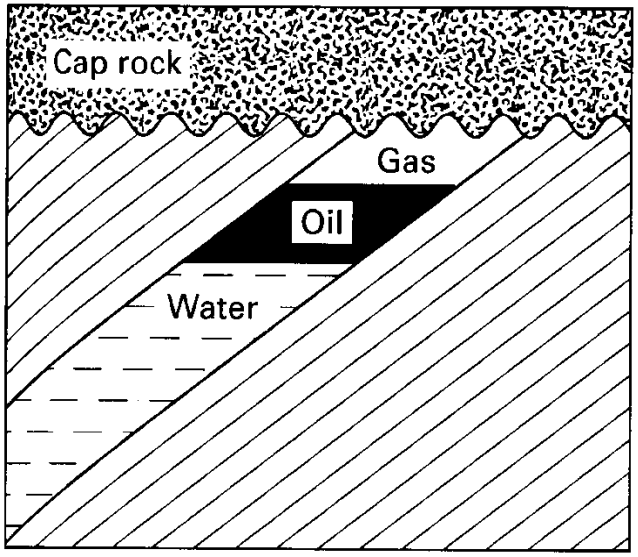
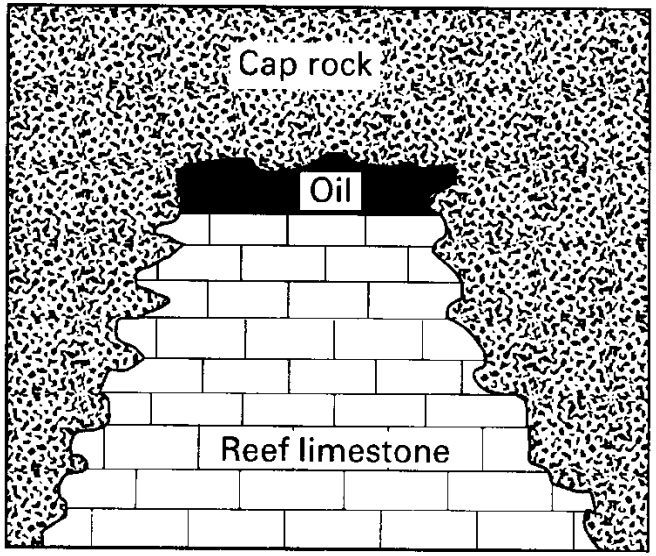


Fig. 25.8 Structural and stratigraphical oil traps. (a) Anticlinal trap developed in a sandstone reservoir in an open, asymmetrical fold. (b) Oil trapped by a fault seal. (c) Schematic diagram of salt dome traps, in supercap, cap rock and flank sandstones (abutting, fault sealed and pinch out). (d) Two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

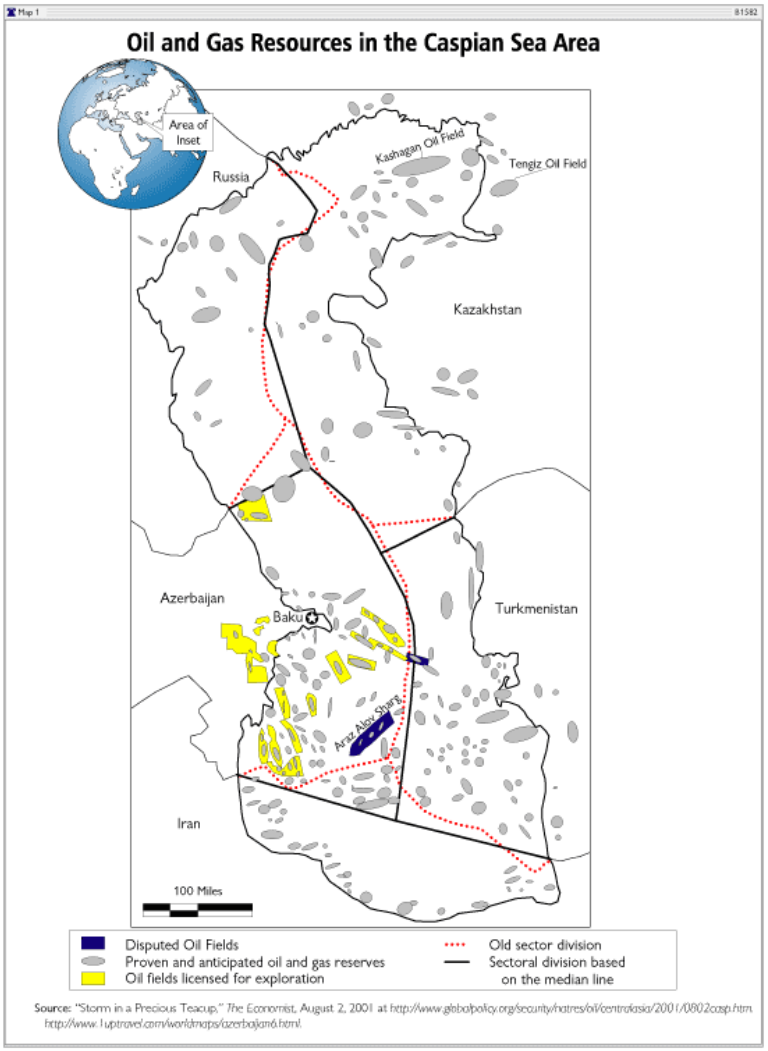
Nejvýznamnější produkční oblasti

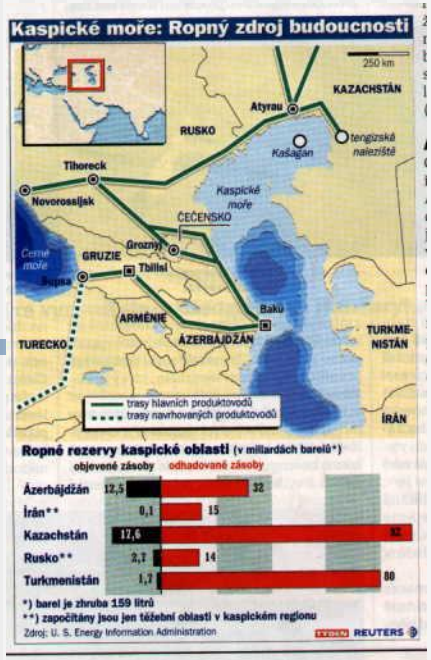
- Perský záliv
- Severní moře
- Rusko (z.Sibiř)
- jv. Asie
- severní Afrika
- …

Kaspická oblast

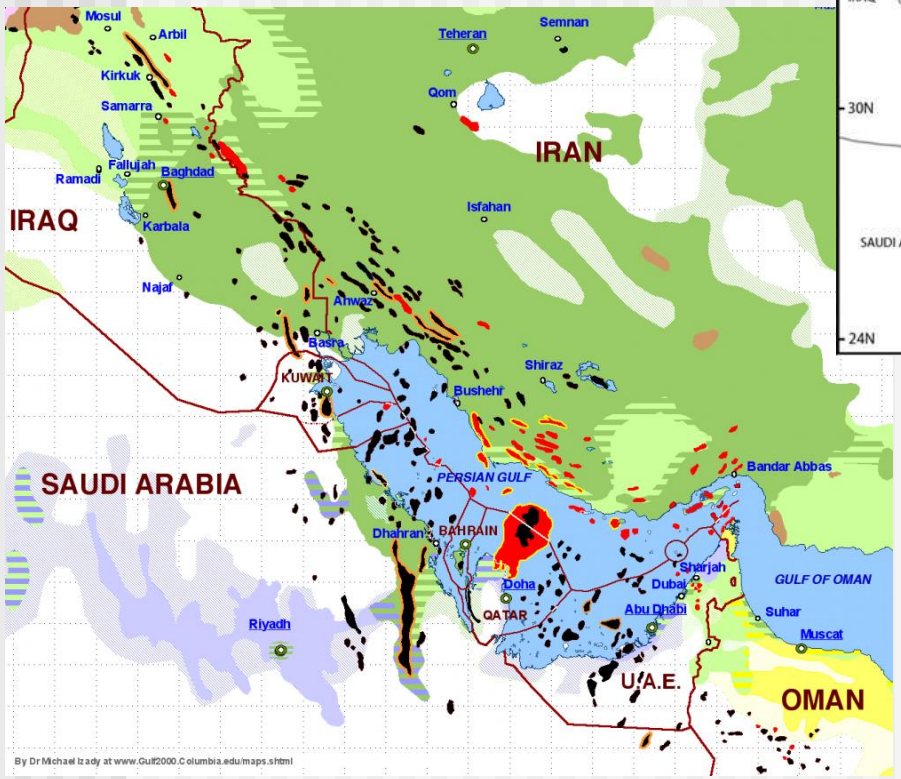
v.Kaspického moře – poloostrov Mangyšlak, ploché vrásové struktury, pískovce sv.jury – ropa, klastika sp.křídy – plyn

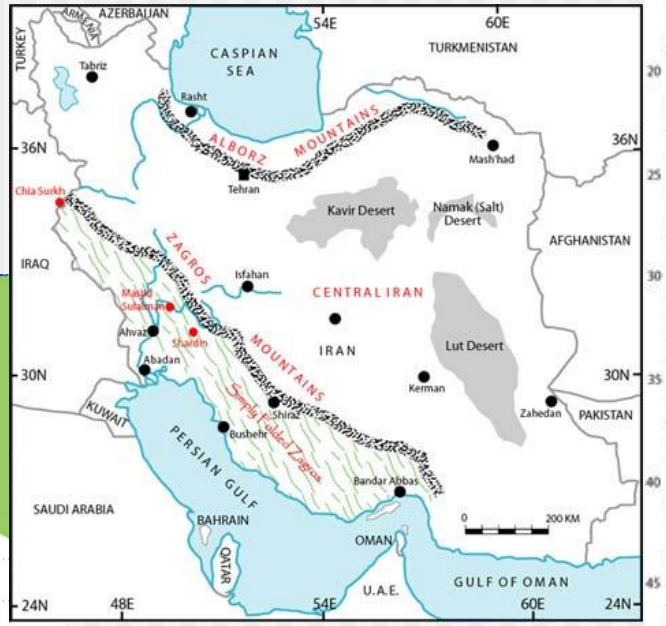
z.pobřeží, Apšeronský poloostrov, oligocén, miocén, pliocén, (paleodelta Volhy)

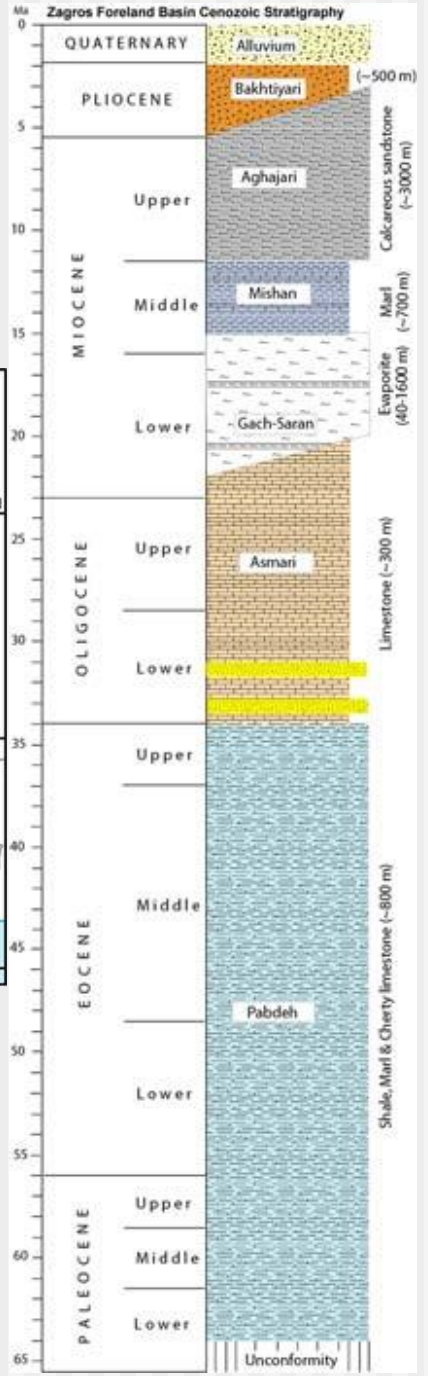




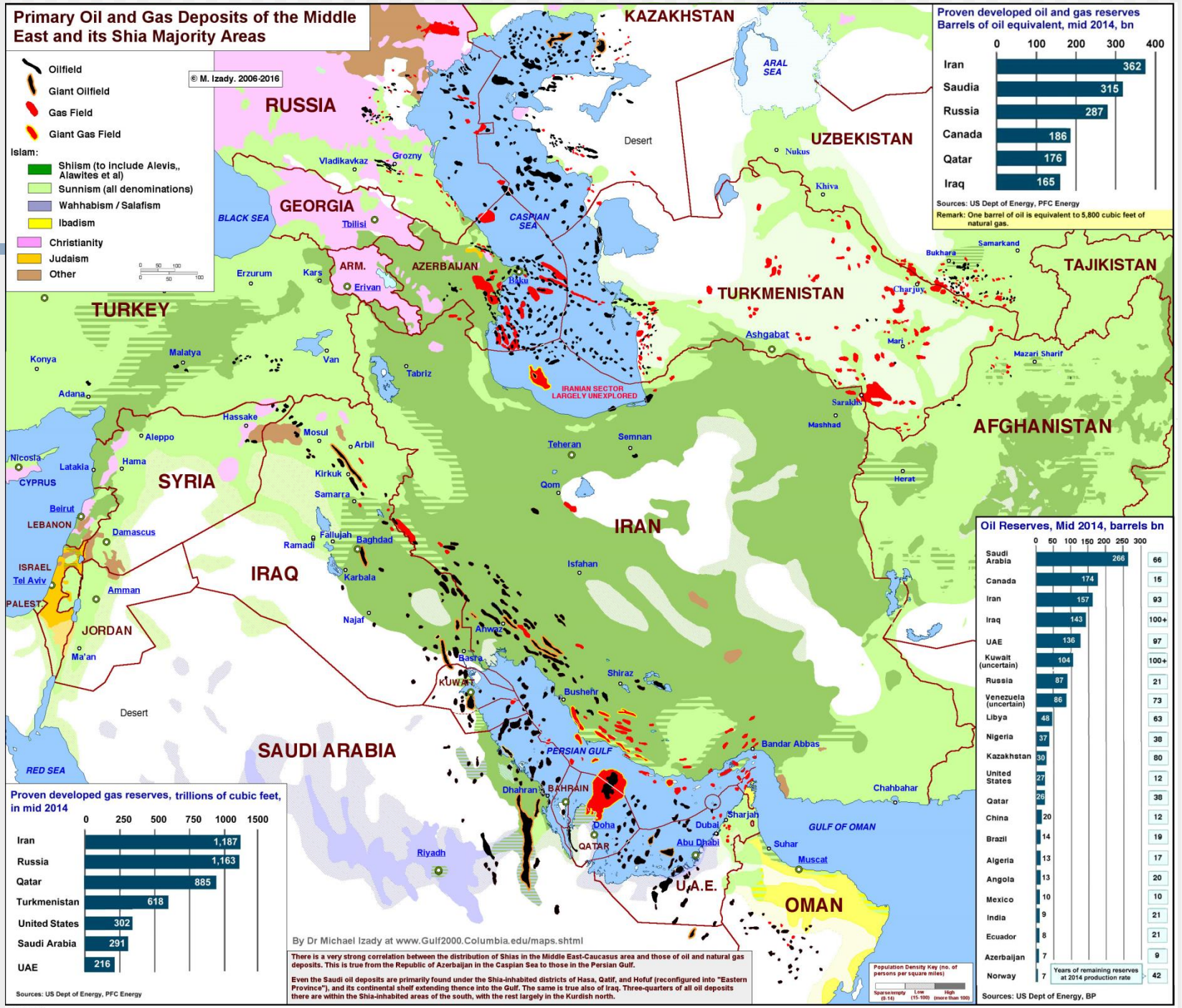
Perský záliv



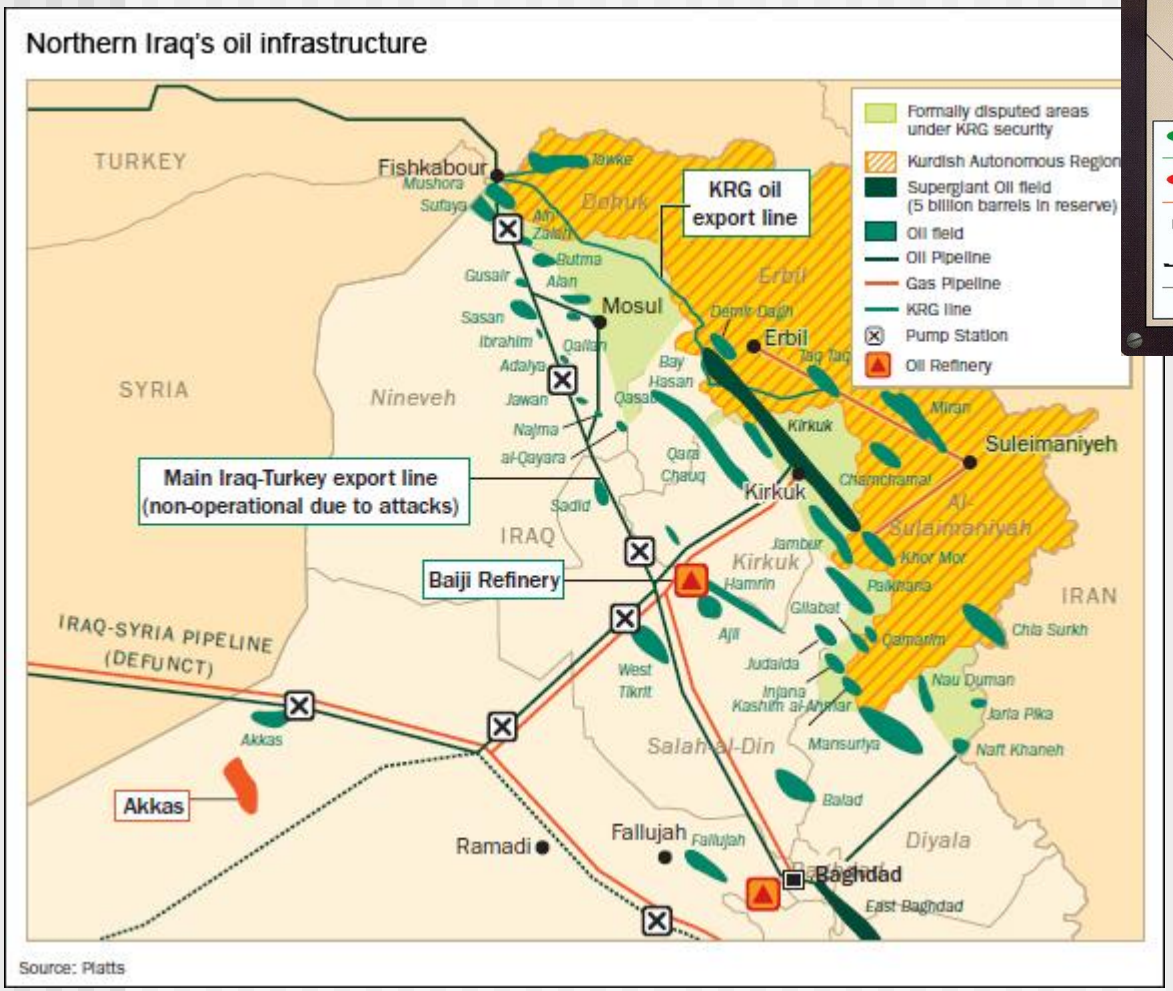




SA - Ghawar – karbonáty, jura, Safaniya – křída
Irán – oligocén, miocén, antiklinální struktury vápenců
Irák – rozsáhlé antiklinály vápenců, eocén, oligocén
Kuvajt – ložisko Burgan, rozsáhlé ploché dómové struktury, křídové pískovce, hloubky 1000-1500m

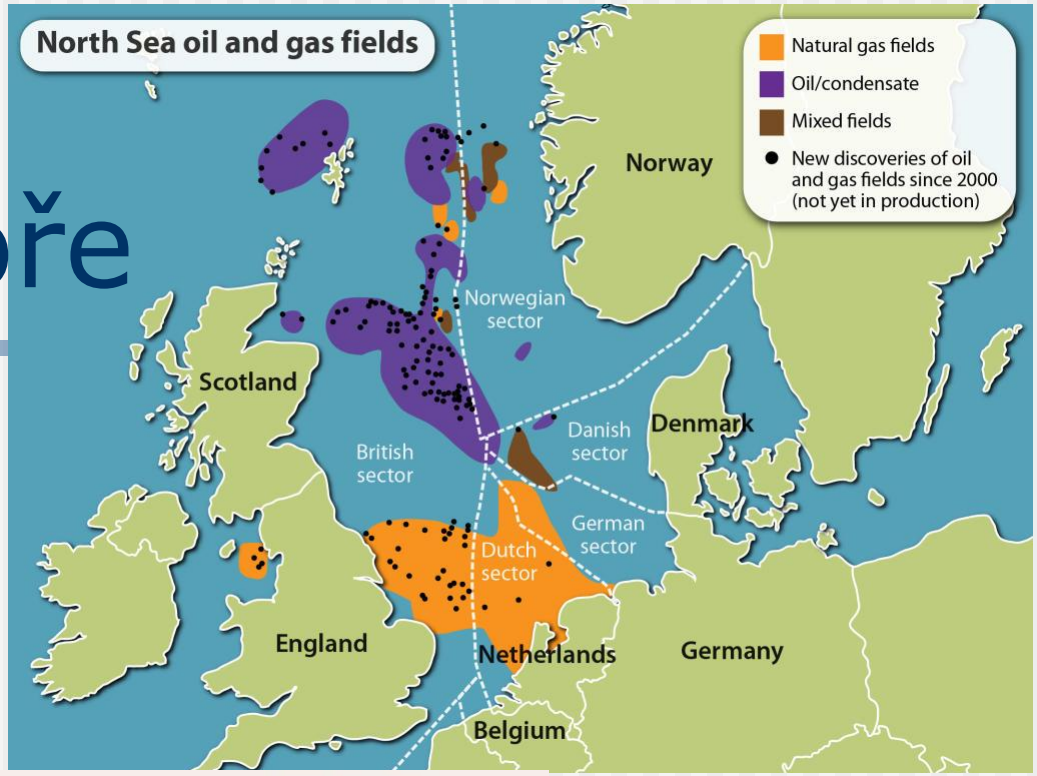

Primary Oil and Gas Deposits of the Middle East and its Shia Majority Areas
Oilfield
Giant Oilfield
Gas Field
Giant Gas Field
Islam:
Shiism (to include Alevis,, Alawites et al)
Sunnism (all denominations)
Wahhabism / Salafism
Ibadism
Christianity
Judaism
Other
© M. Izady. 2006-2016
KAZAKHSTAN
RUSSIA
ARAL SEA
Desert
UZBEKISTAN
Nukus
Khiva
Vladikavkaz
Grozny
GEORGIA
Tbilisi
BLACK SEA
CASPIAN SEA
Samarkand
Bukhara
TAJIKISTAN
ARM.
AZERBAIJAN
Erzurum
Kars
Erivan
Baku
Charjuy
TURKMENISTAN
TURKEY
Ashgabat
Mari
Konya
Malatya
Van
Tabriz
Mazari Sharif
IRANIAN SECTOR LARGELY UNEXPLORED
Adana
Sarakhs
Hassake
Mosul
Arbil
Aleppo
Mashhad
AFGHANISTAN
Teheran
Semnan
Nicosia
Latakia
Hama
Kirkuk
Herat
CYPRUS
SYRIA
Samarra
Qom
Beirut
LEBANON
Damascus
Fallujah
Ramadi
Baghdad
IRAN
ISRAEL
Tel Aviv
IRAQ
Karbala
Isfahan
Amman
PALEST.
Najaf
JORDAN
Ahwaz
Ma'an
Basra
KUWAIT
Shiraz
Bushehr
Desert
Bandar Abbas
SAUDI ARABIA
PERSIAN GULF
RED SEA
Dhahran
BAHRAIN
Chahbahar
Doha
Dubai
Sharjah
GULF OF OMAN
QATAR
Abu Dhabi
Suhar
Riyadh
Muscat
U.A.E.
OMAN
Proven developed oil and gas reserves
Barrels of oil equivalent, mid 2014, bn
0 100 200 300 400
Iran 362
Saudia 315
Russia 287
Canada 186
Qatar 176
Iraq 165
Sources: US Dept of Energy, PFC Energy
Remark: One barrel of oil is equivalent to 5,800 cubic feet of natural gas.
Proven developed gas reserves, trillions of cubic feet, in mid 2014
0 250 500 750 1000 1500
Iran 1,187
Russia 1,163
Qatar 885
Turkmenistan 618
United States 302
Saudi Arabia 291
UAE 216
Sources: US Dept of Energy, PFC Energy
Oil Reserves, Mid 2014, barrels bn
0 50 100 150 200 250 300
Saudi Arabia 266 66
Canada 174 15
Iran 157 93
Iraq 143 100+
UAE 136 97
Kuwait (uncertain) 104 100+
Russia 87 21
Venezuela (uncertain) 86 73
Libya 48 63
Nigeria 37 38
Kazakhstan 30 80
United States 27 12
Qatar 26 38
China 20 12
Brazil 14 19
Algeria 13 17
Angola 13 20
Mexico 10 10
India 9 21
Ecuador 8 21
Azerbaijan 7 9
Norway 7 42
Years of remaining reserves at 2014 production rate
Sources: US Dept of Energy, BP
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.
Population Density Key (no. of persons per square miles)
Sparse/empty (0-14)
Low (15-100)
High (more than 100)
Version 11

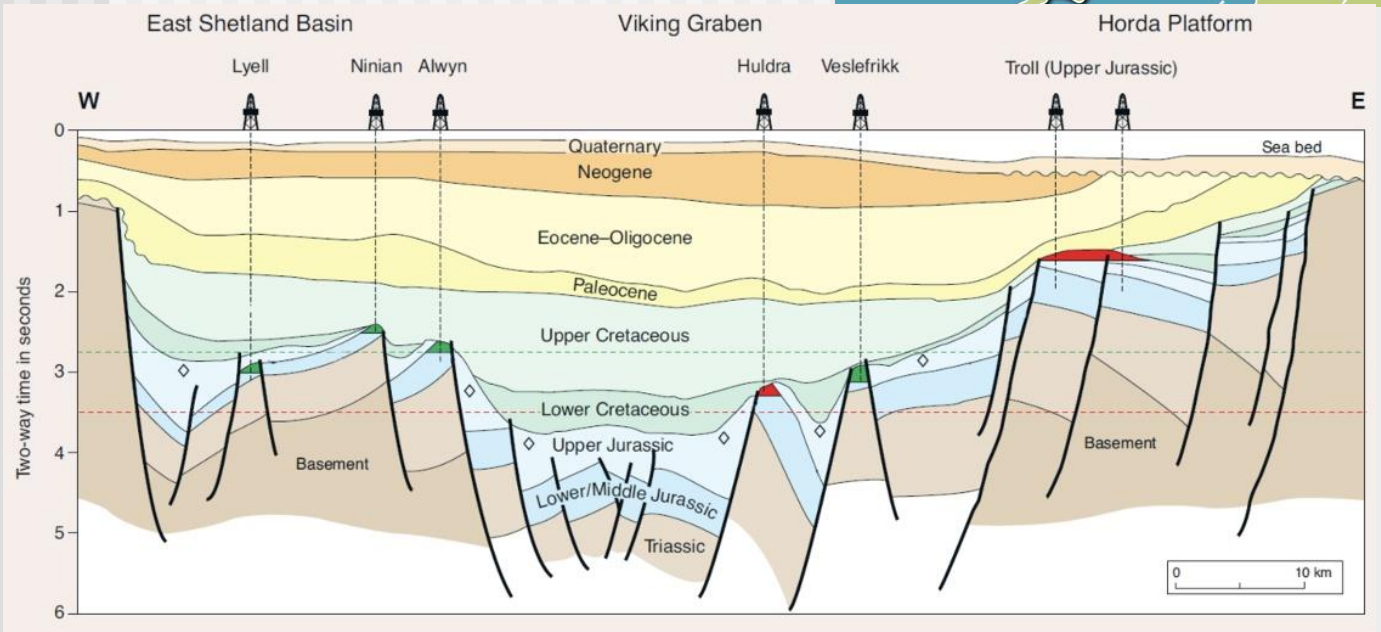
Perský záliv



Severní moře

ploché antiklinální struktury, karbonské dolomity, jurské pískovce



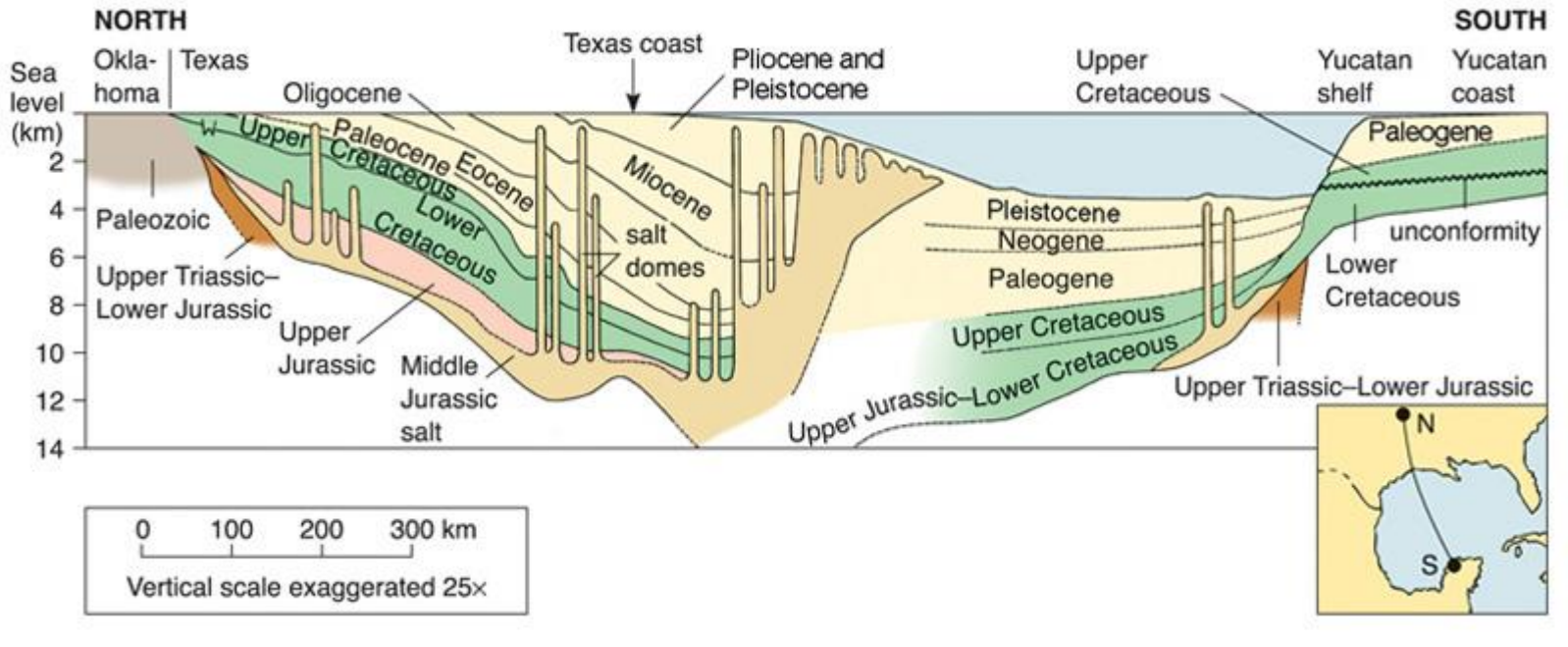


Ropa a zemní plyn v ČR

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

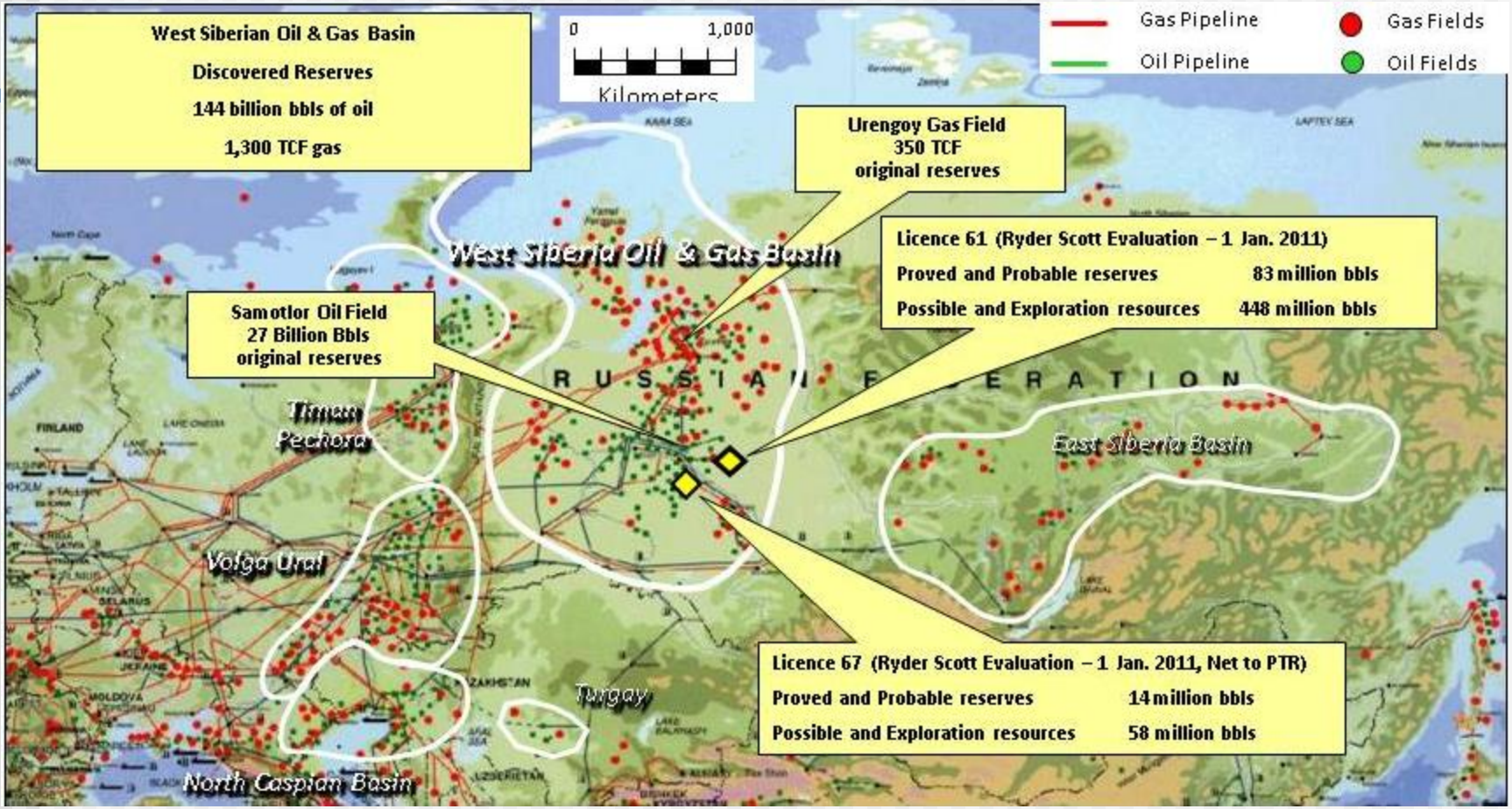
Obr. 11.2 Pozice Českého masivu a Karpatské soustavy v rámci geologické stavby Evropy

Mexico basin



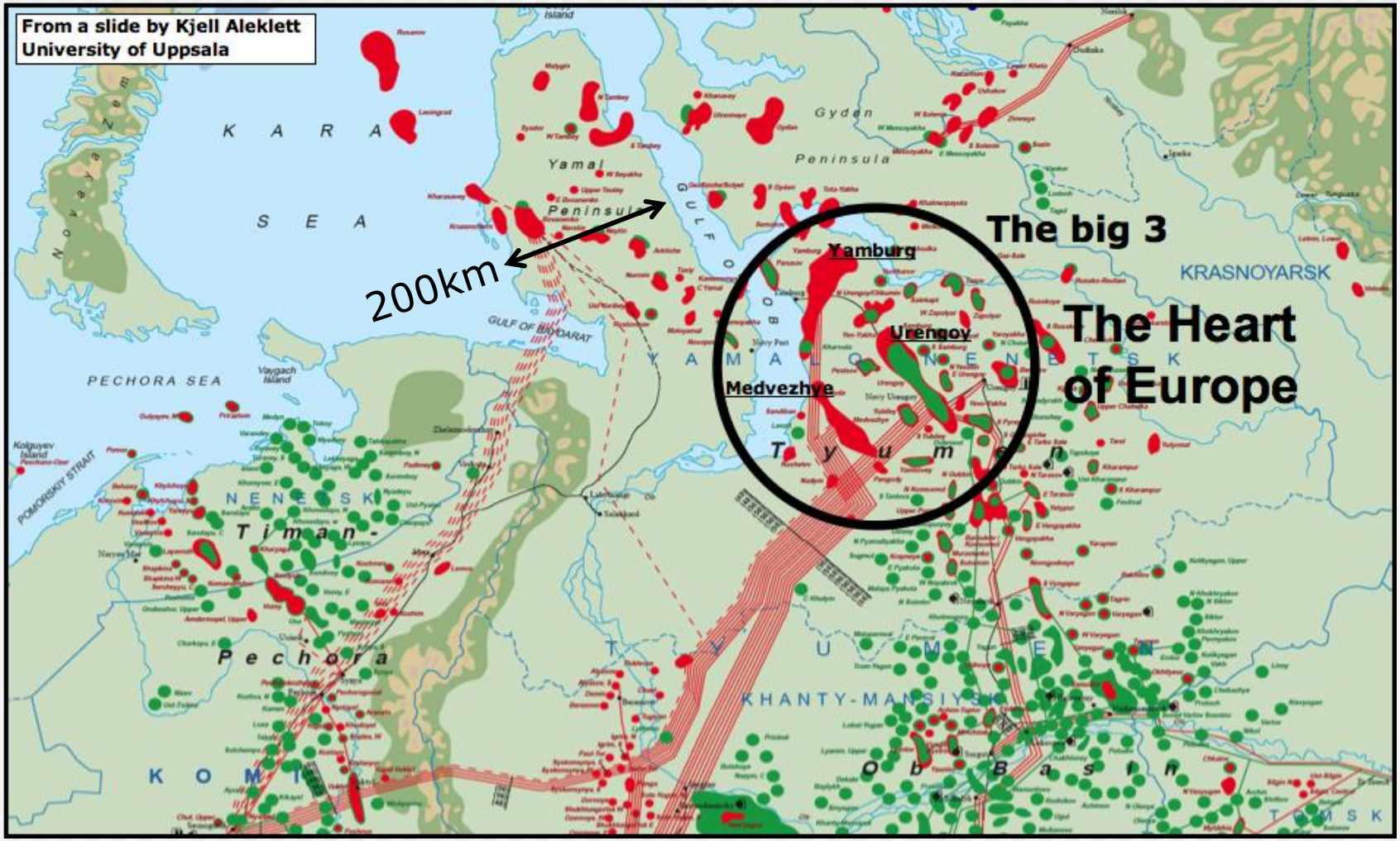
Geologic cross section through the Gulf of Mexico basin.

Rusko - uhlovodíky

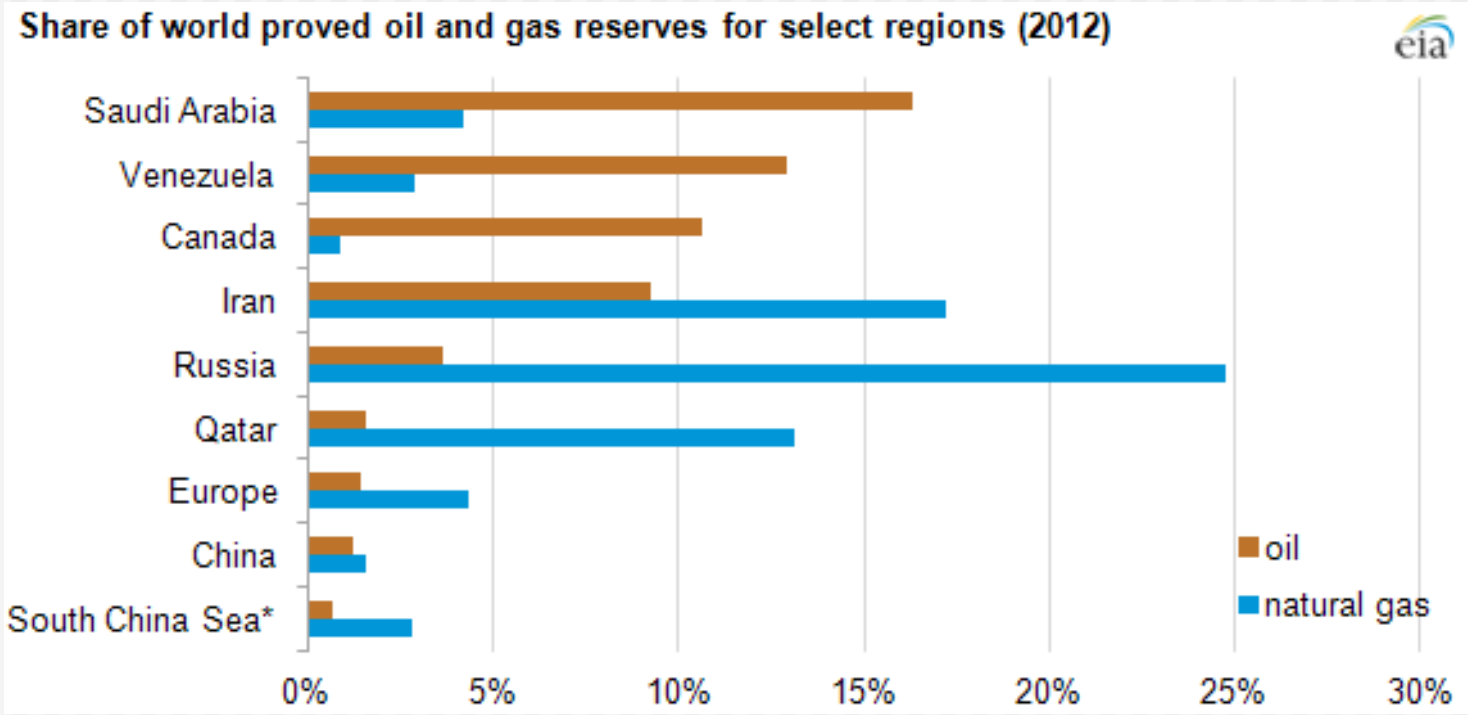


západosibiřská provincie – jurská a křídová klastika
východosibiřská provincie – kambrické, prekambrické hor., permské a křídové sedimenty

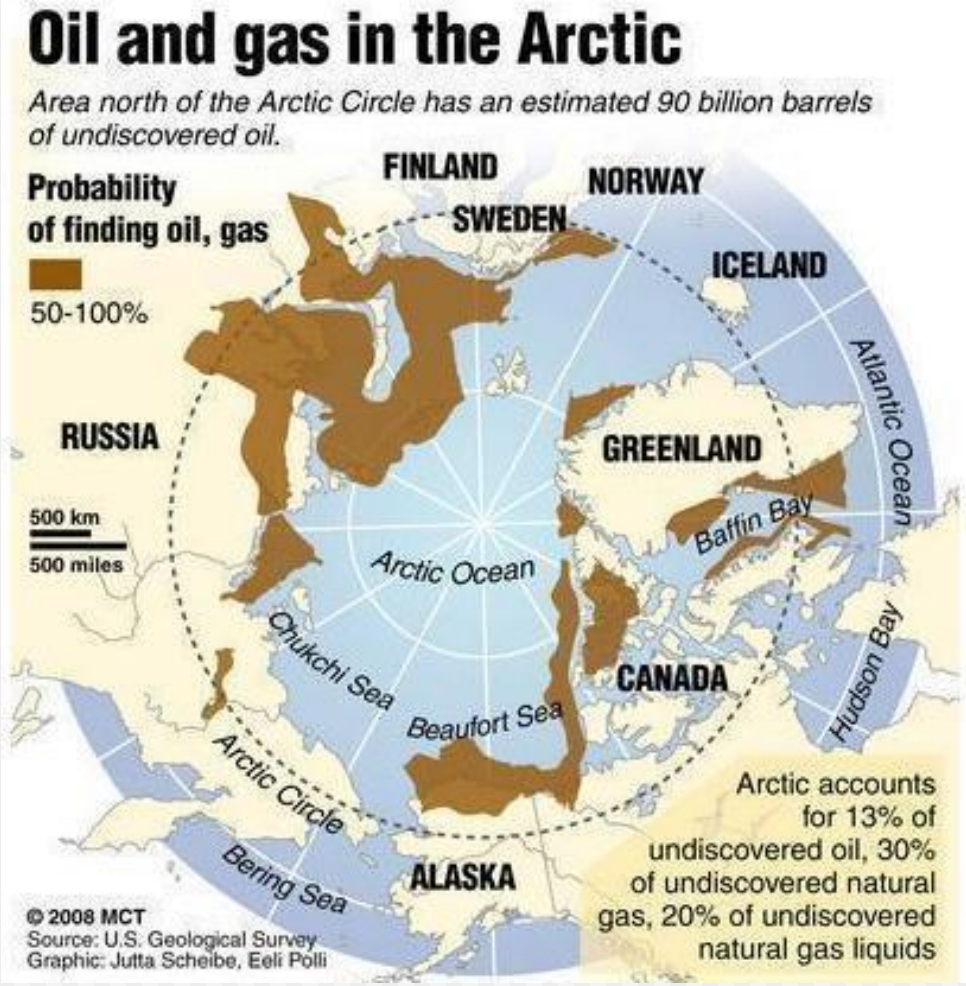
Velká ložiska z.Sibiře



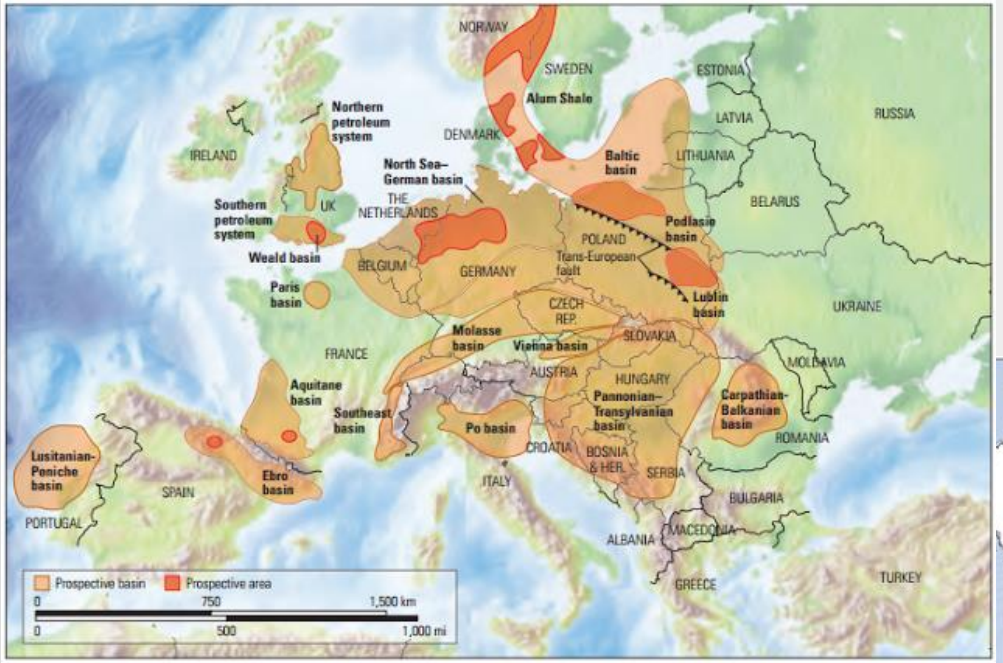
Oil and gas reserves



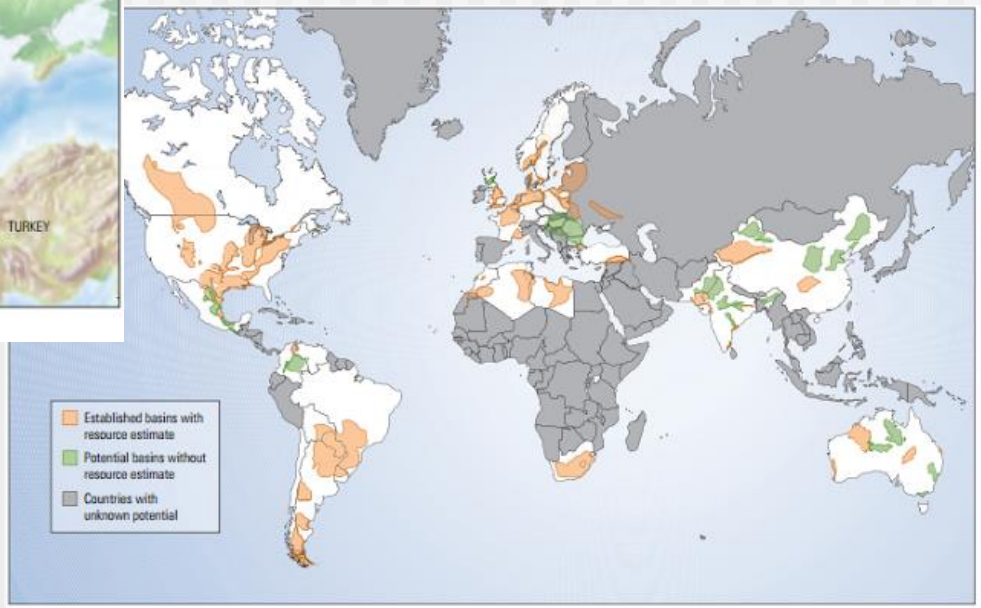
Arktida


Oil and gas in the Arctic
Area north of the Arctic Circle has an estimated 90 billion barrels of undiscovered oil.
Probability of finding oil, gas
50-100%
FINLAND
NORWAY
SWEDEN
ICELAND
RUSSIA
GREENLAND
Atlantic Ocean
500 km
500 miles
Baffin Bay
Arctic Ocean
Chukchi Sea
Hudson Bay
CANADA
Beaufort Sea
Arctic Circle
Bering Sea
ALASKA
Arctic accounts for 13% of undiscovered oil, 30% of undiscovered natural gas, 20% of undiscovered natural gas liquids
© 2008 MCT
Source: U.S. Geological Survey
Graphic: Jutta Scheibe, Eeli Polli

Plyn z břidlic – „břidlicový plyn“ – shale gas

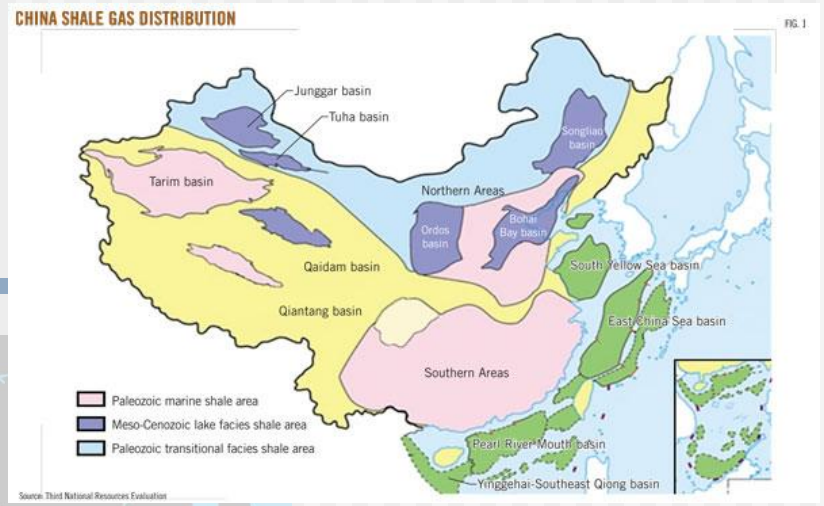


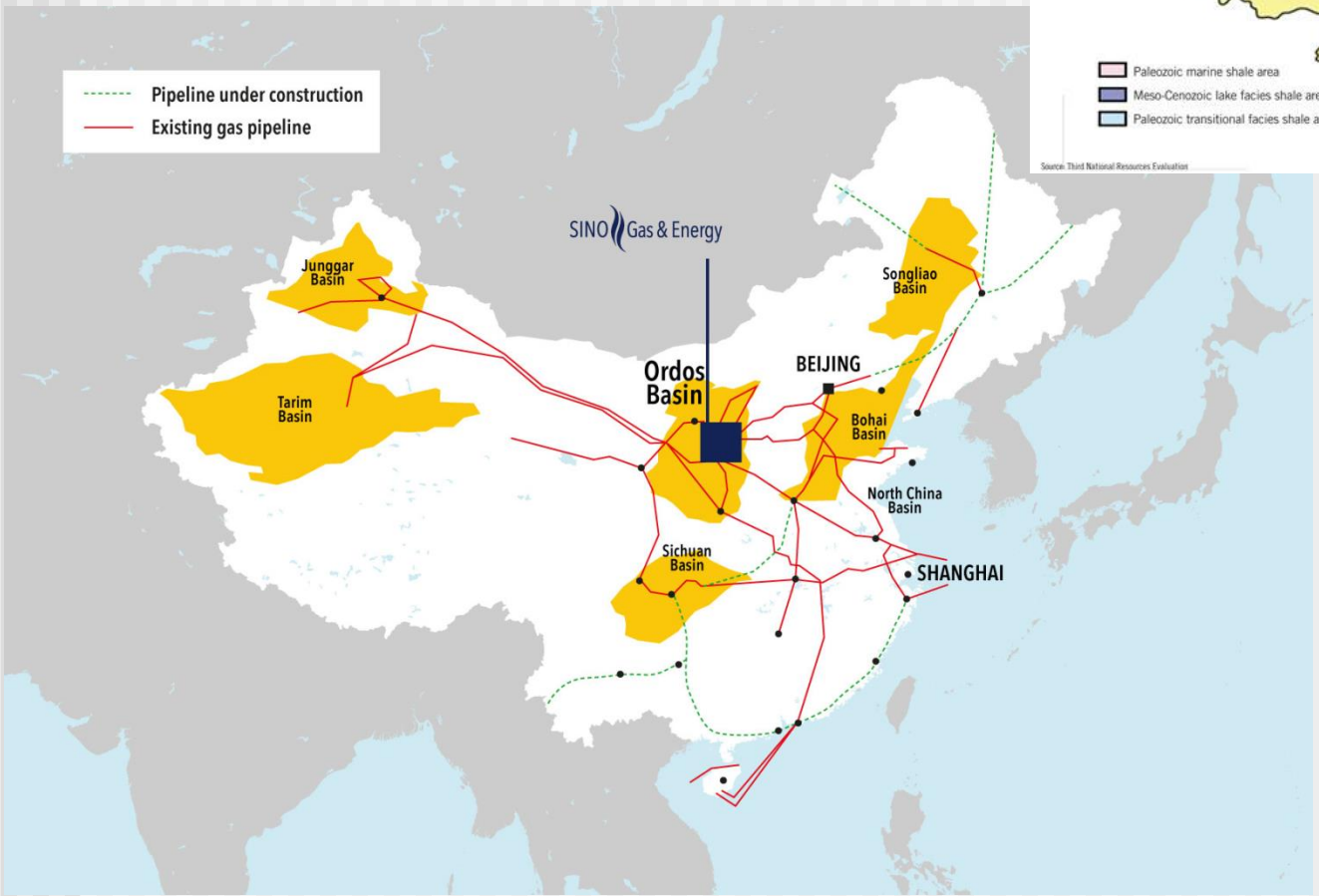
^ Europe shale basins. (Adapted from Kuuskraa et al, reference 6.)



^ 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.)

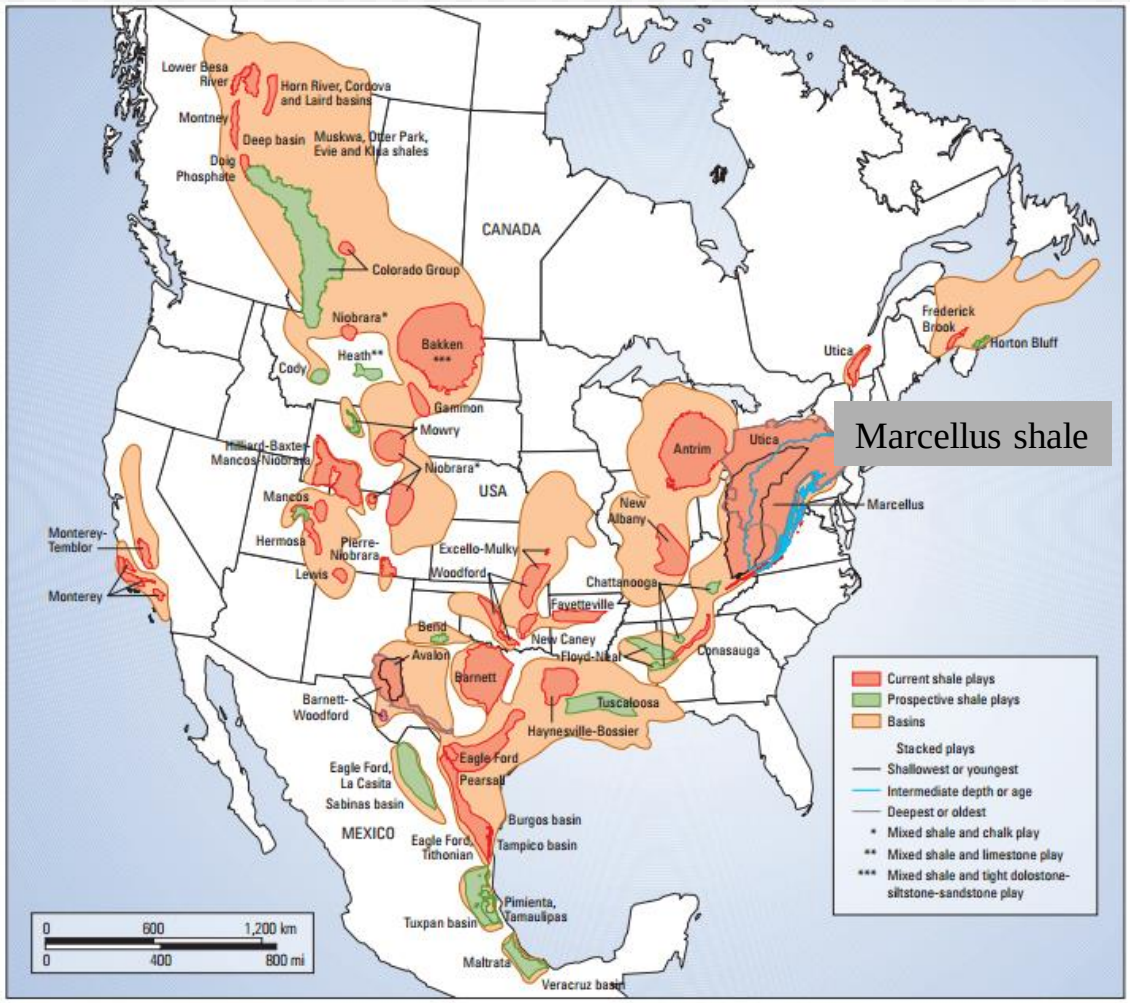
Čína


CHINA SHALE GAS DISTRIBUTION
FIG. 1
Junggar basin
Tuha basin
Songliao basin
Tarim basin
Northern Areas
Ordos basin
Bohai Bay basin
Qaidam basin
South Yellow Sea basin
Qiantang basin
East China Sea basin
Southern Areas
Paleozoic marine shale area
Meso-Cenozoic lake facies shale area
Paleozoic transitional facies shale area
Pearl River Mouth basin
Yinggehai-Southeast Qiong basin
Source: Third National Resources Evaluation


Pipeline under construction
Existing gas pipeline
SINO Gas & Energy
Junggar Basin
Tarim Basin
Ordos Basin
Songliao Basin
BEIJING
Bohai Basin
North China Basin
Sichuan Basin
SHANGHAI

shale gas - USA

stabilizace cen energií?



Marcellus shale

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

Další zdroje uhlovodíků

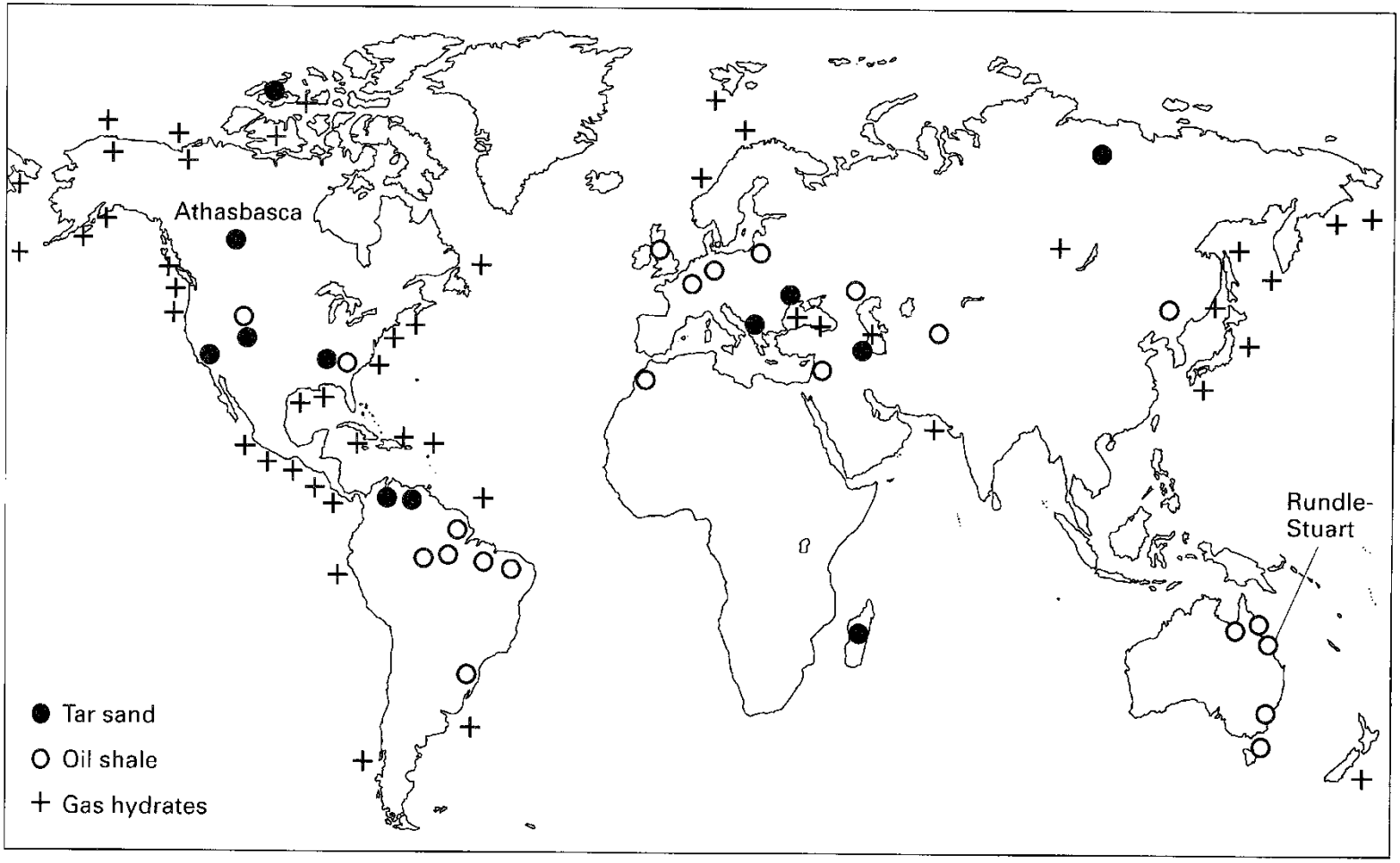
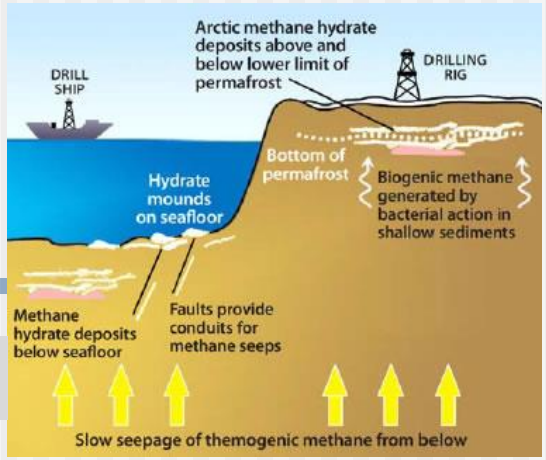
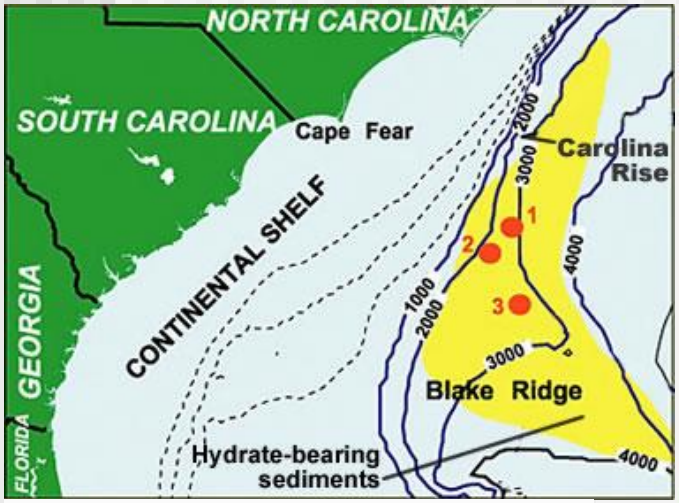


Fig. 25.13 World distribution of important tar sand and oil shale deposits, and the known occurrences of gas hydrates.

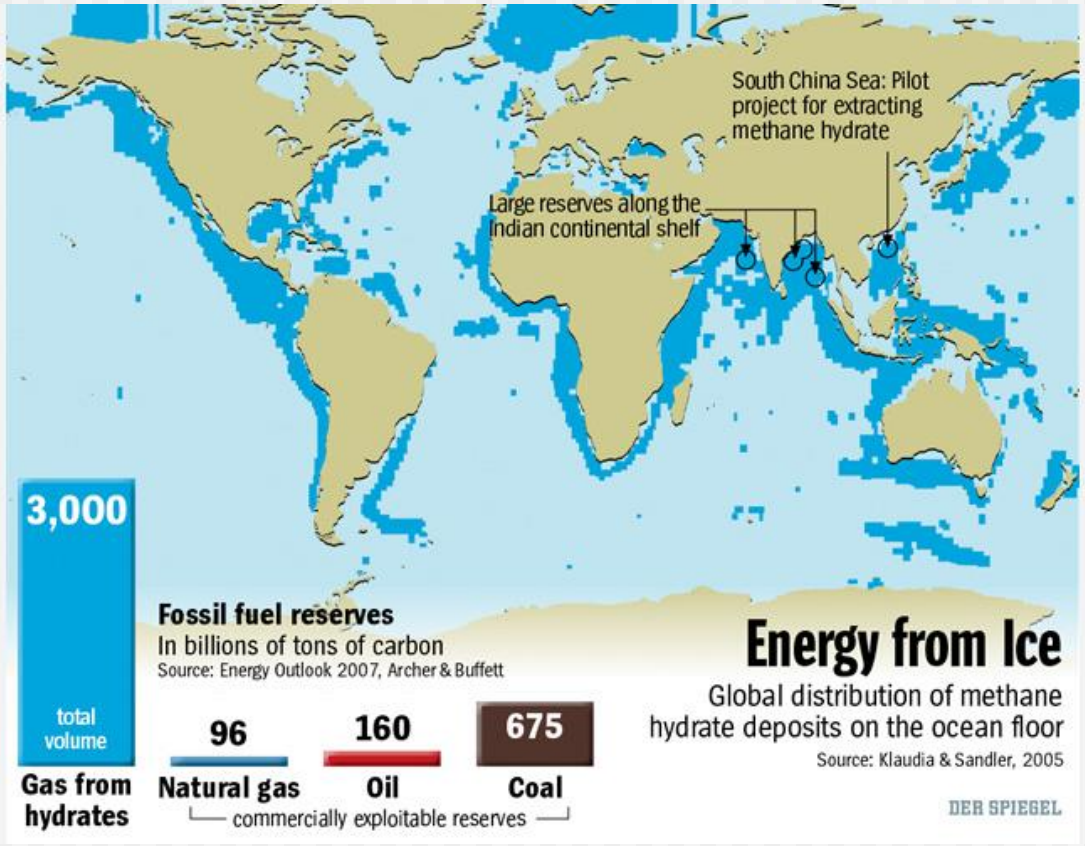
Rozšíření hydrátů metanu



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.



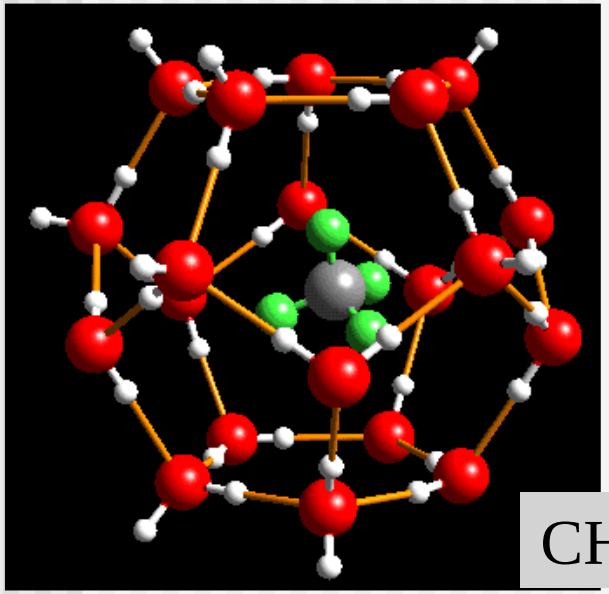
Hydráty metanu I.

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

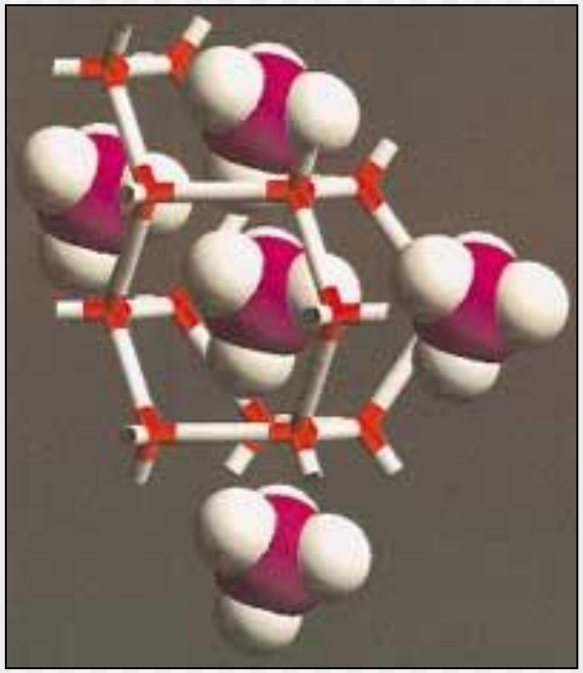
struktura led-metan

Hydráty metanu II.

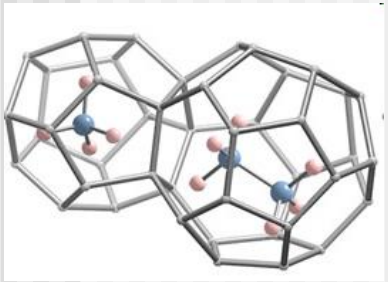
Van der Waalsovy síly



slabší než vodíkové můstky,
vzájemné působení molekulových dipólů



$CH_4.7H_2O$



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

„8“$CH_4\,46H_2O$

Image courtesy Southwest Research Institute.

http://www.netl.doe.gov/technologies/oil-gas/FutureSupply/MethaneHydrates/about-hydrates/chemistry.htm

Jak vypadají makroskopicky?

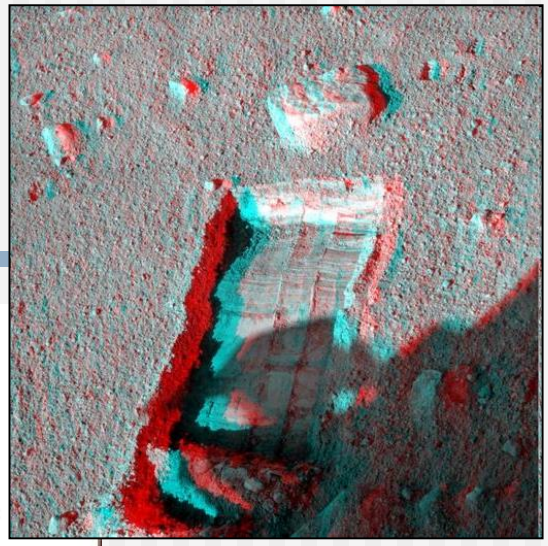
Hester KC, Brewer PG. 2009.
Annu. Rev. Mar. Sci. 1:303–27

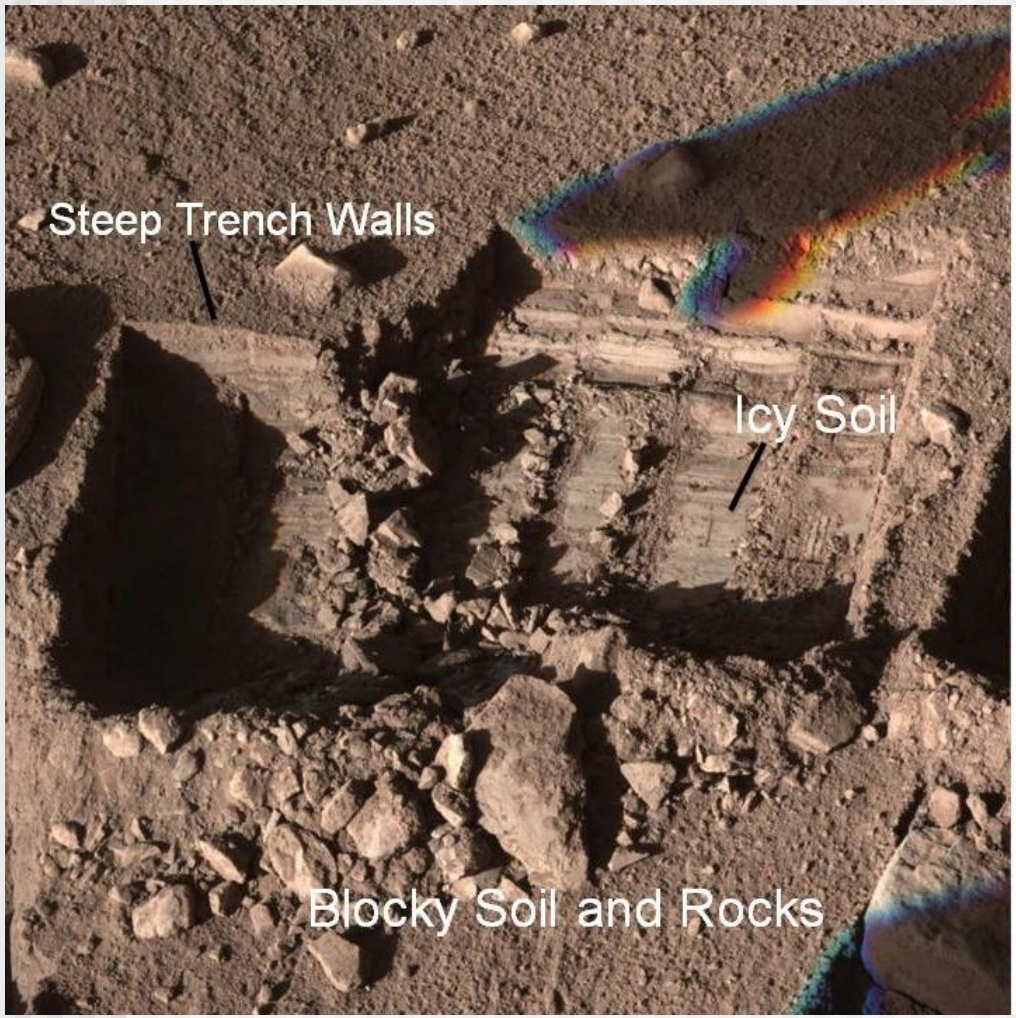
A close-up of methane hydrate observed at a depth of 3,460 feet (1,055 meters) off the U.S. Atlantic Coast. NOAA Okeanos Explorer Program/2013 Northeast U.S. Canyons Expedition.

Důsledky složení a struktury

(Credit: Image courtesy of U.S. Department of Energy)

Mars





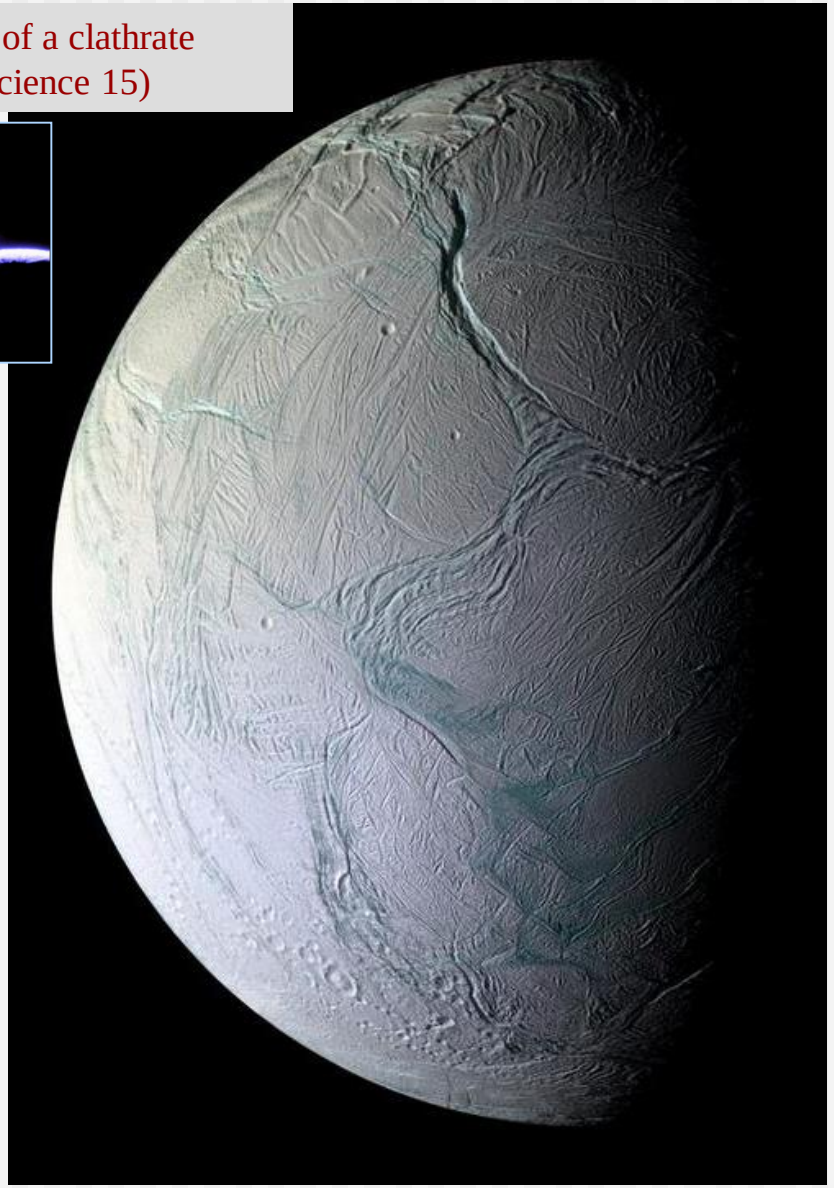
Sol 148 View

LaMancha Trench

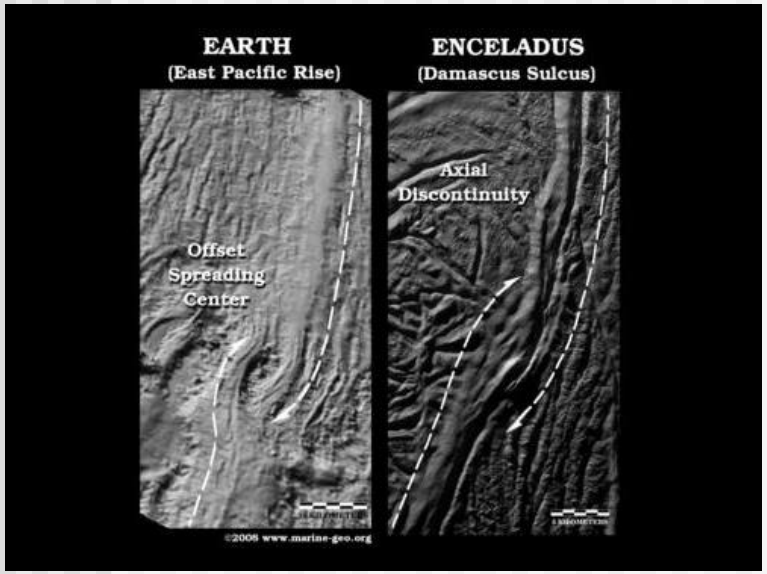
Icy soil few cm beneath blocky soil

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

Enceladus

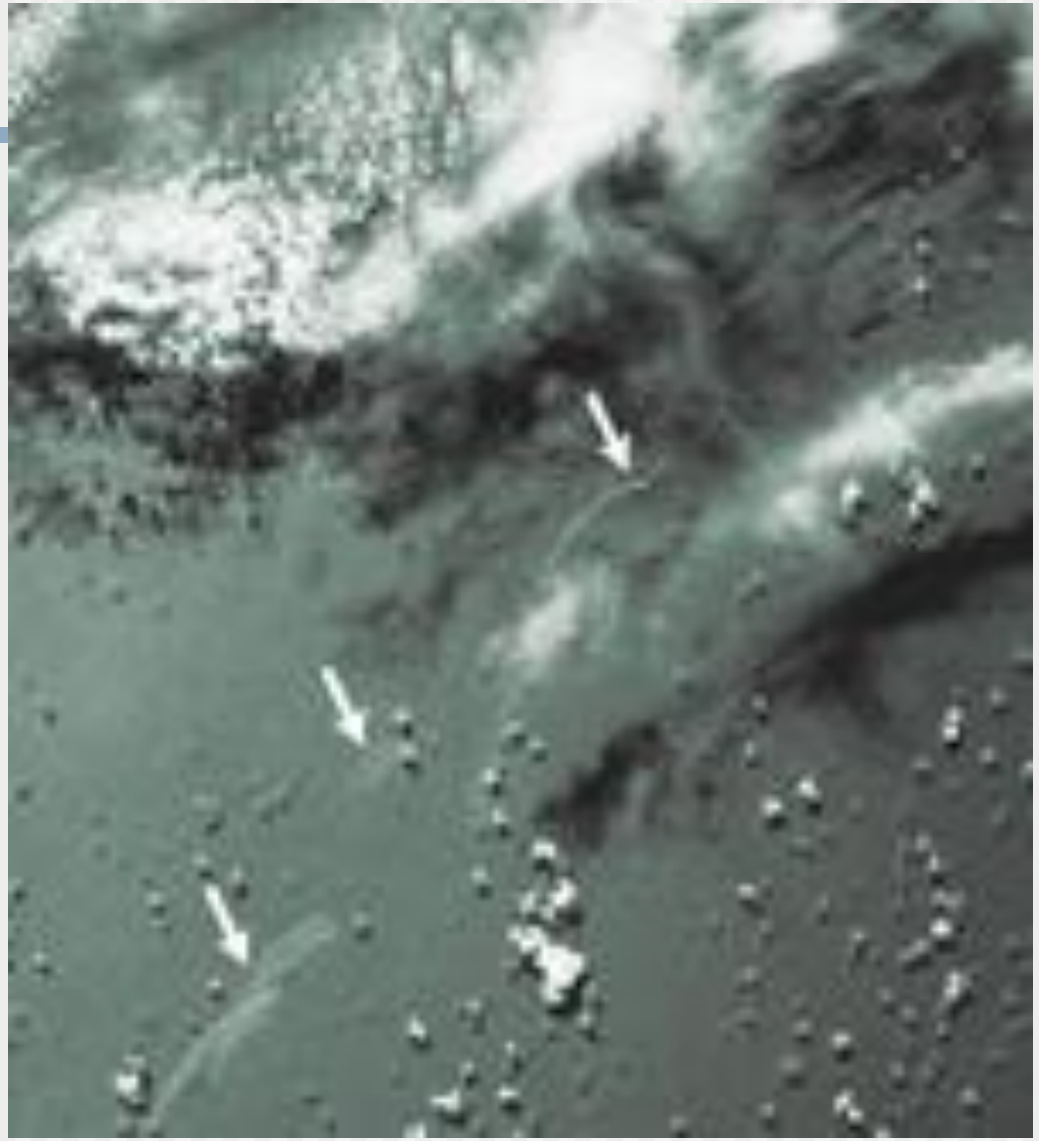


Enceladus in Eclipse
January 7, 2009
The image was taken in visible light with the Cassini spacecraft narrow-angle camera on Oct. 31, 2008 at a distance of approximately 137,000 kilometers (85,100 miles) from Enceladus (moon of Saturn)



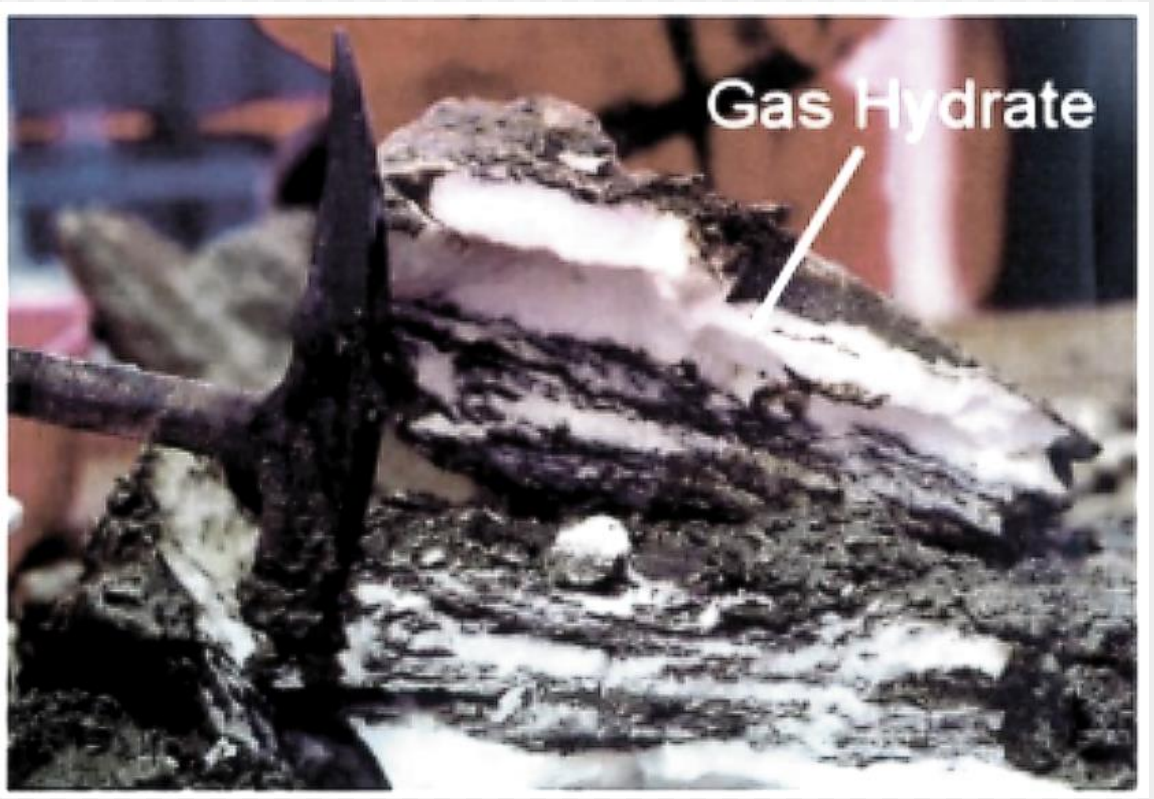
Enceladus Offset Spreading Center
December 15, 2008

I na Zemi - uvolňování metanu

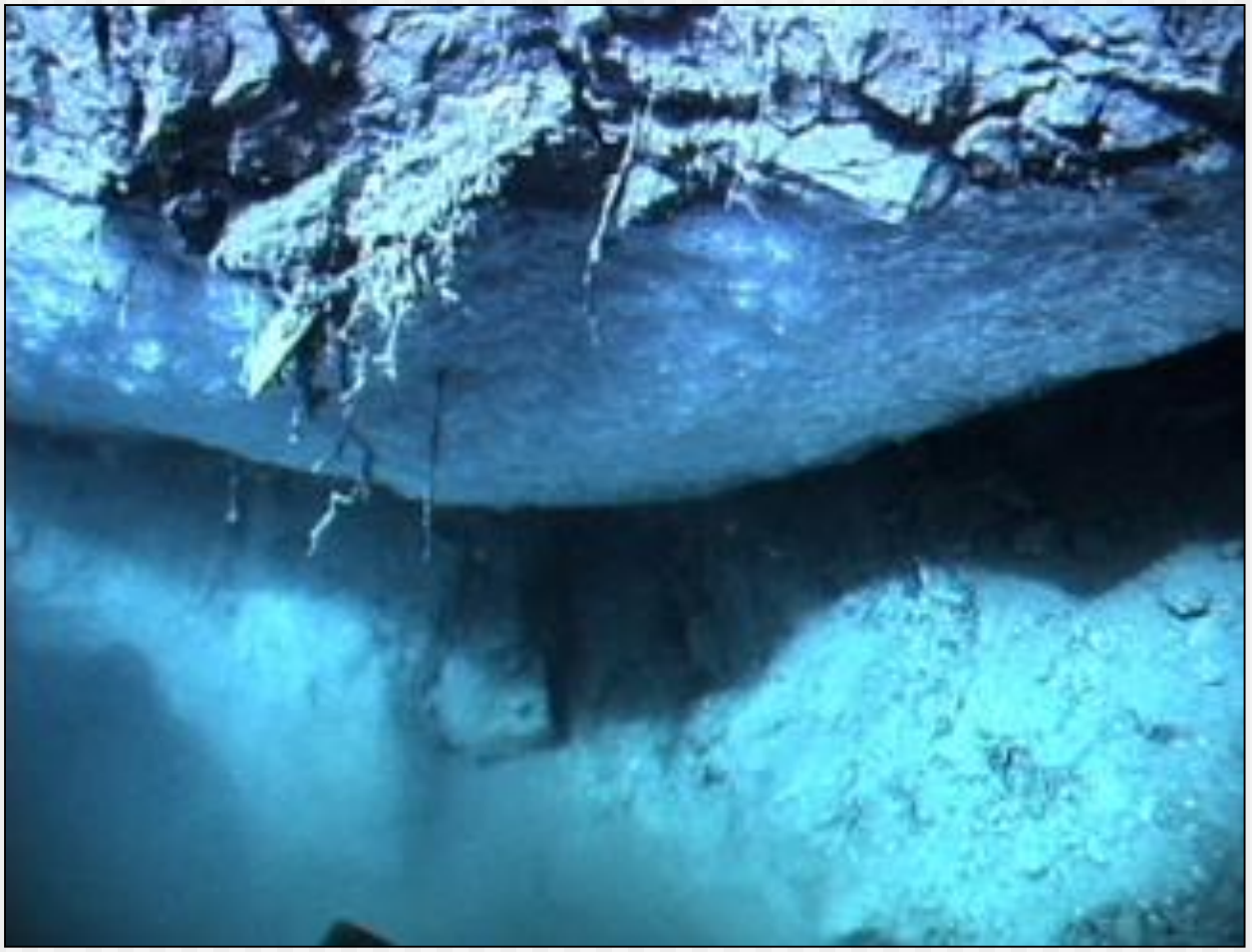


This colorized image of the ocean surface taken from the space shuttle makes the sea and clouds look like an artist's abstract dabs and brushstrokes. The bright streaks are oil slicks produced by hydrocarbons seeping naturally from seafloor vents.

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)

$CH_2O + O_2 \rightarrow CO_2 + H_2O$ (1)

$2CH_2O + SO_4^{2-} \rightarrow 2CO_2 + S^{2-} + 2H_2O$ (2)

$CH_4 + SO_4^{2-} \rightarrow CO_2 + S^{2-} + 2H_2O$ (3)

$2CH_2O \rightarrow CH_4 + CO_2$ (4)

$CO_2 + 8e^- + 8H^+ \rightarrow CH_4 + 2H_2O$ (5)

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 ~100°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:

$$CH_2O + O_2 \rightarrow CO_2 + H_2O \quad (1)$$
$$2CH_2O + SO_4^{2-} \rightarrow 2CO_2 + S^{2-} + 2H_2O \quad (2)$$
$$CH_4 + SO_4^{2-}; \rightarrow CO_2 + S^{2-} + 2H_2O \quad (3)$$
$$2CH_2O \rightarrow CH_4 + CO_2 \quad (4)$$
$$CO_2 + 8e^- + 8H^+ \rightarrow CH_4 + 2H_2O \quad (5)$$

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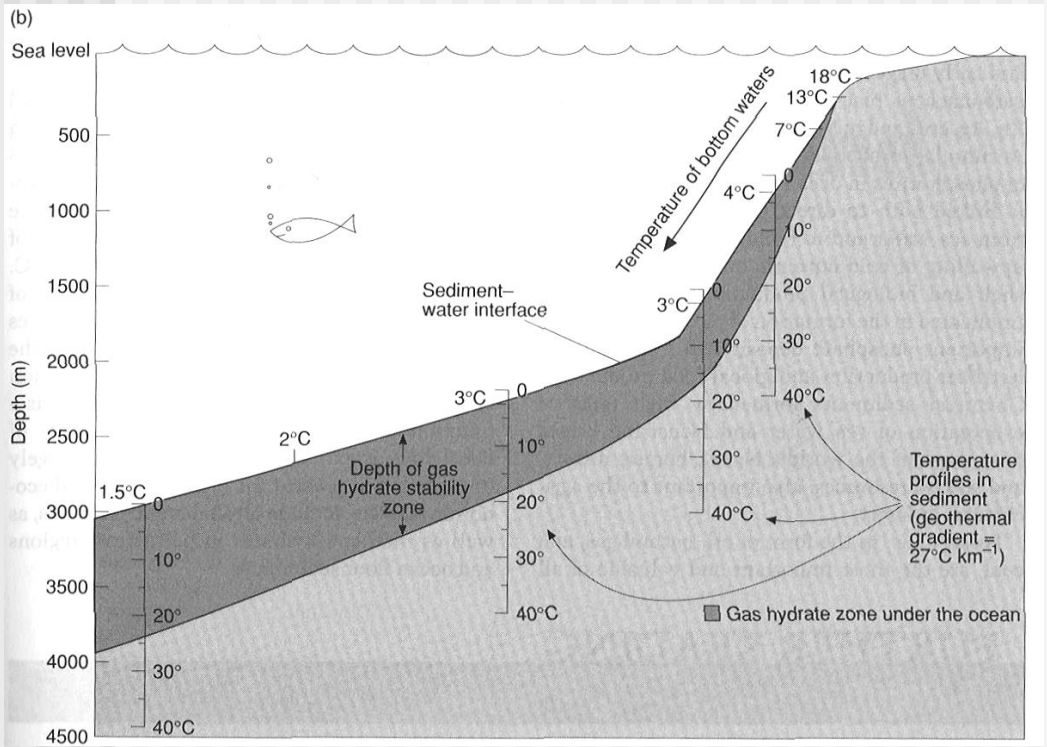
Stabilita fází systému H_2O-CH_4



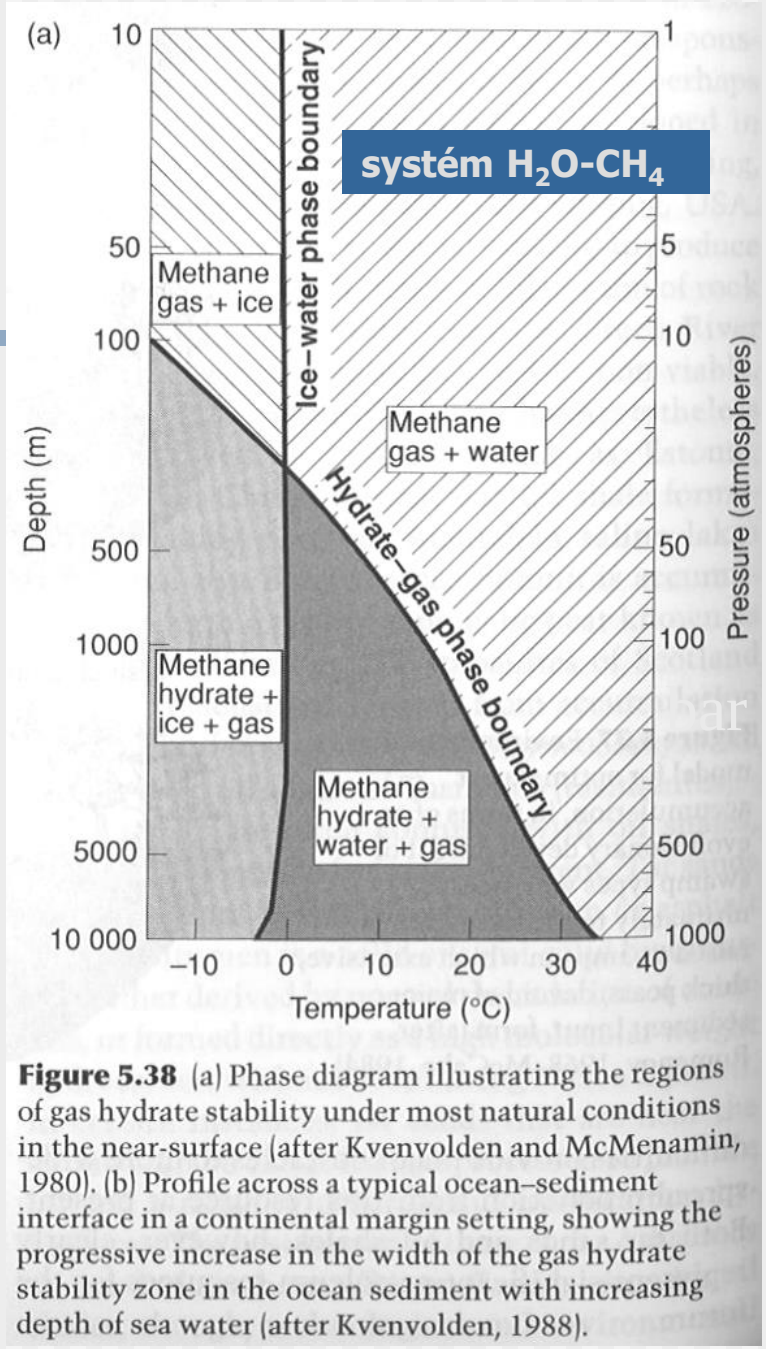
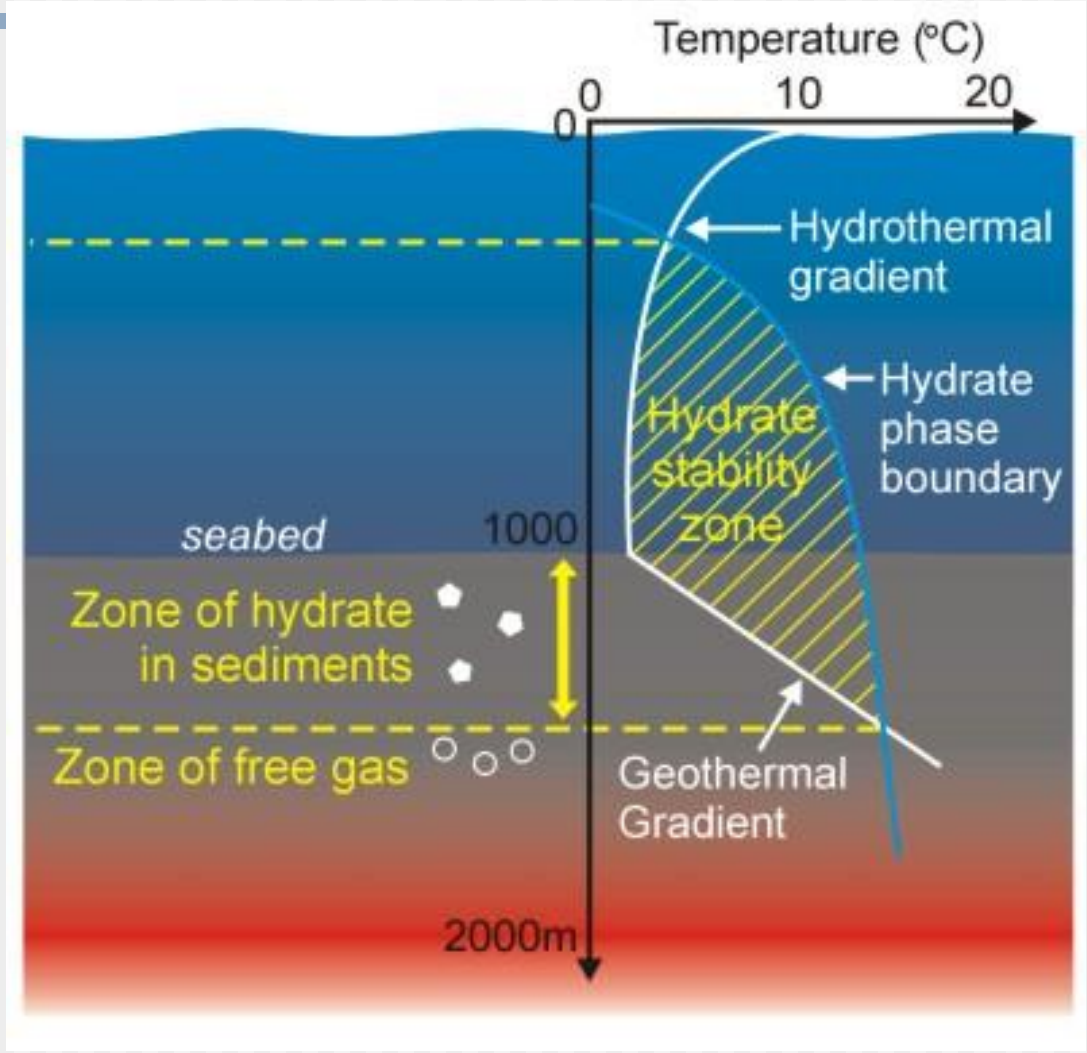


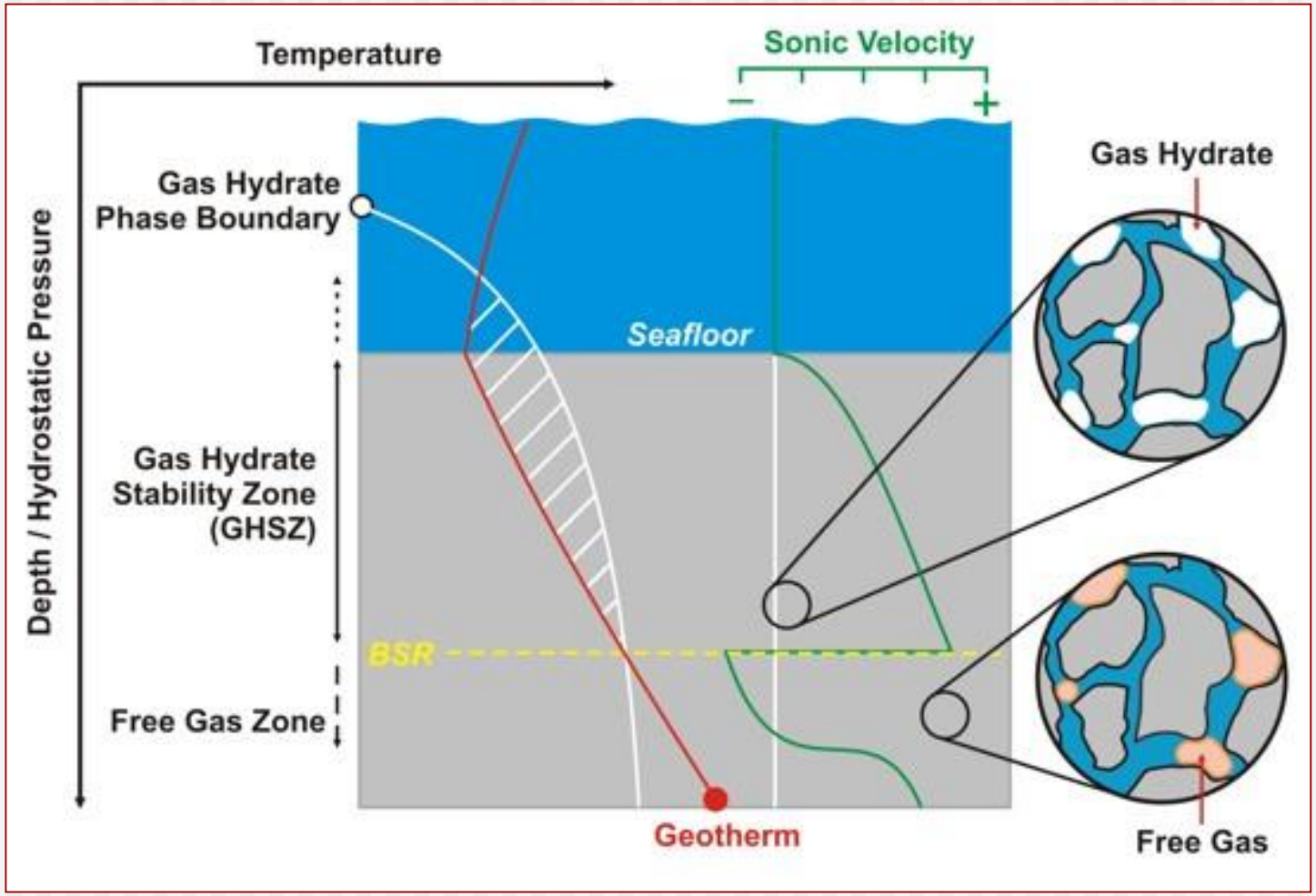
Figure 5.38 (a) Phase diagram illustrating the regions of gas hydrate stability under most natural conditions in the near-surface (after Kvenvolden and McMenamin, 1980). (b) Profile across a typical ocean–sediment interface in a continental margin setting, showing the progressive increase in the width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

Stabilita hydrátů CH_4



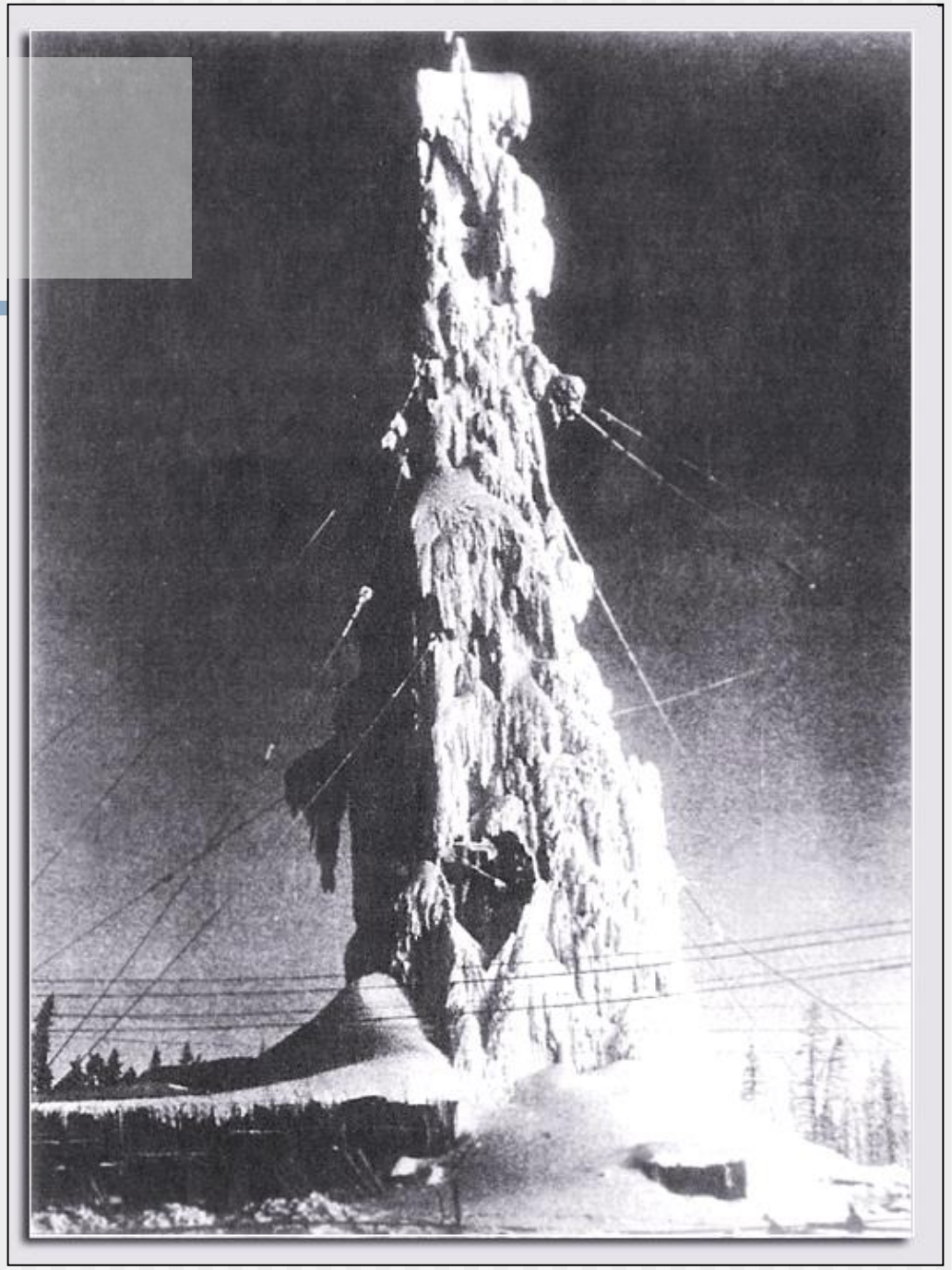
The Hydrate Stability Zone in Subsea Sediments

Hydráty v mořských sedimentech



http://www.pet.hw.ac.uk/research/hydrate/hydrates_where.cfm

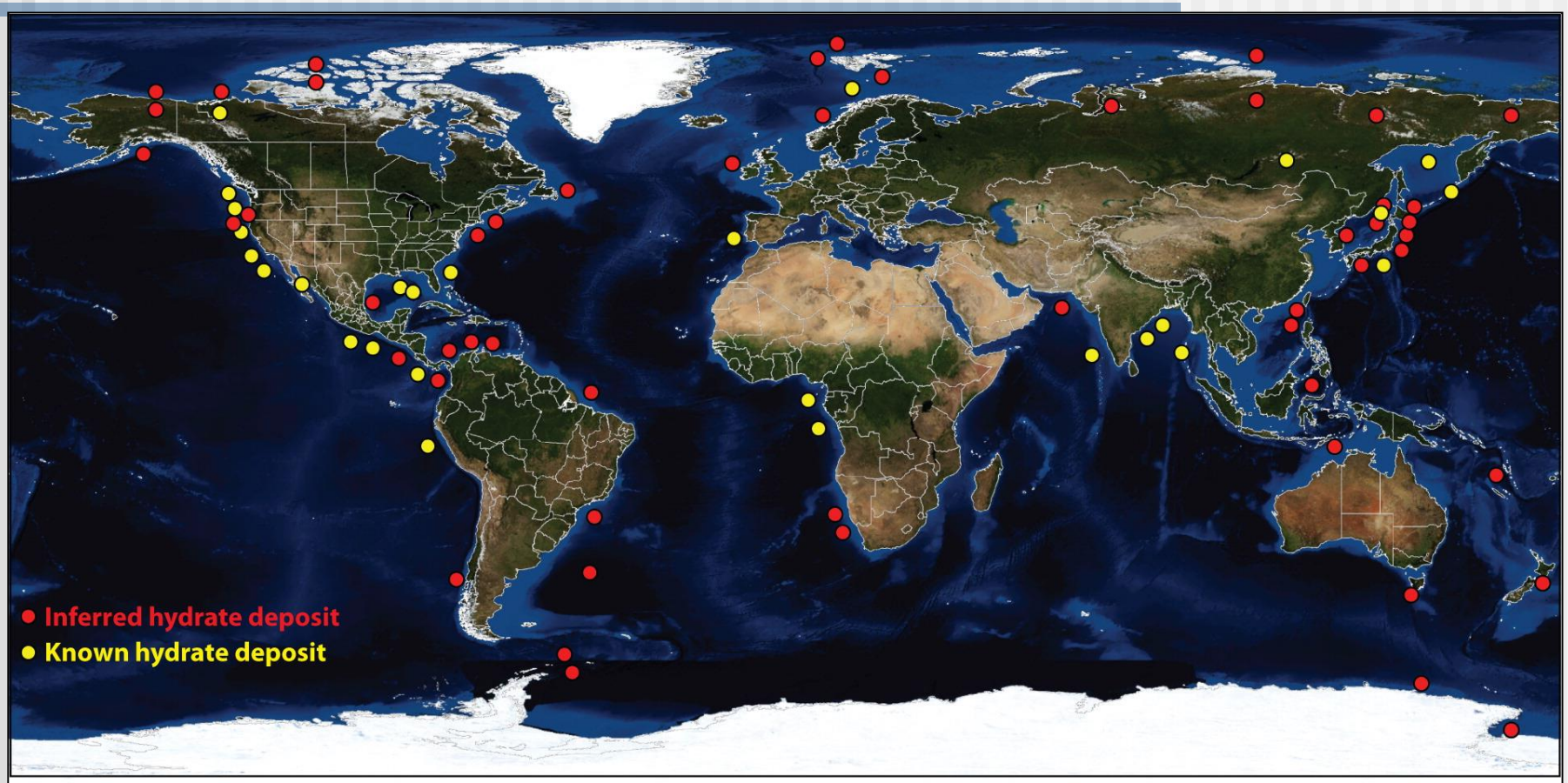
Hydráty - Sibiř



*A huge pillar of solidified (natural) gas hydrate produced in a methane pipeline rupture under below-zero (-63oC) 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).

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

Průzkum a prognózy



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

Zdroje hydrátů v číslech

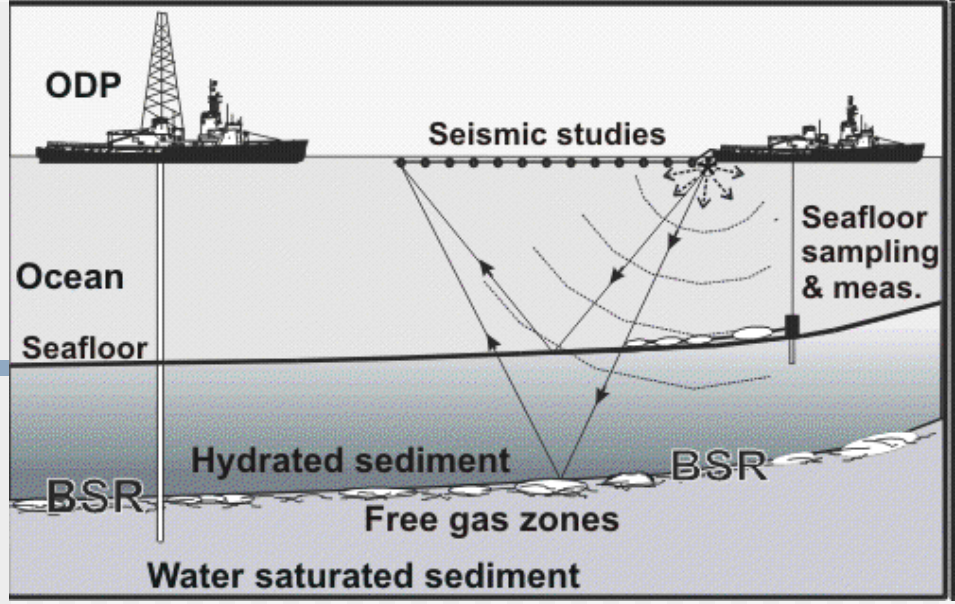
Table 2 Conventional and hydrated gas resources in trillion cubic metres

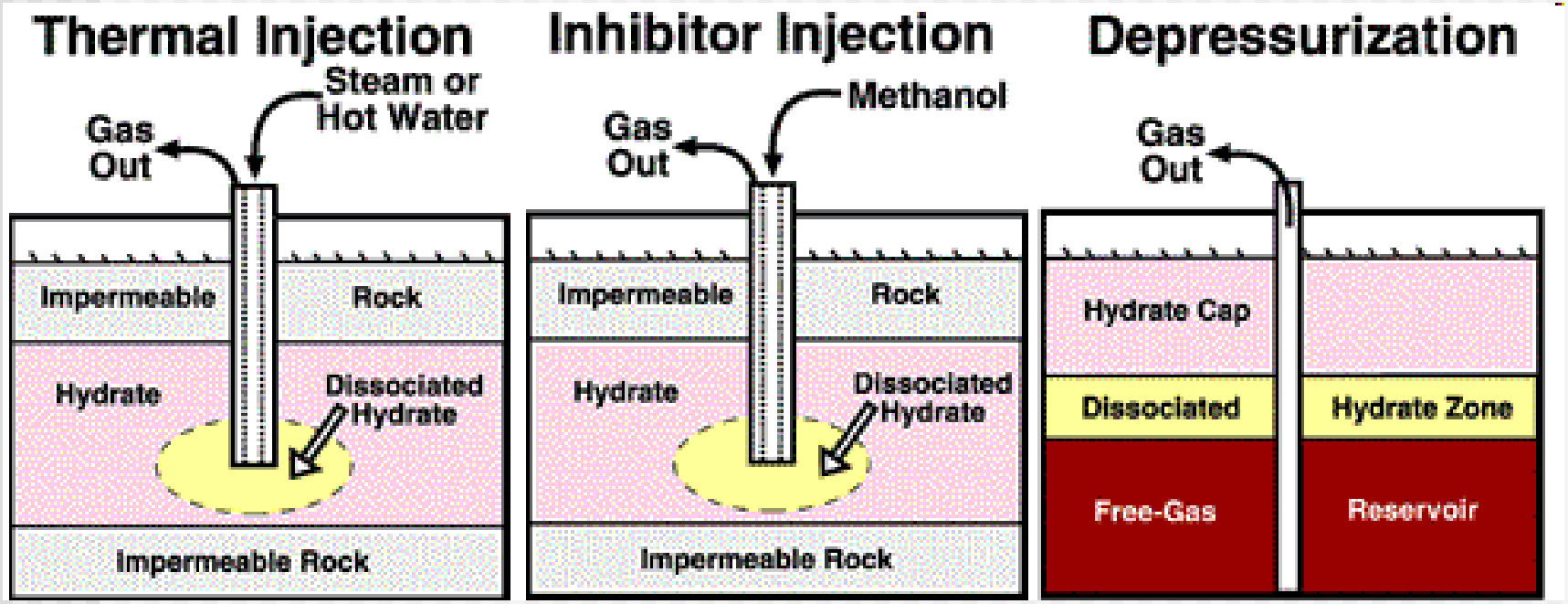
Region	Conventional gas (TCM)	Methanehydrate (TCM)
North America	32.82	6,853
Latin America and Caribbean	21.1	5,139
Western Europe	15.27	856
Central and Eastern Europe	2.05	0
Former Soviet Union	117	4,711
Middle East and North Africa	77.2	214
Sub-Saharan Africa	13.9	429
Central Asia and China	10.07	429
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

http://www.gas-hydrate.org.cn/permafrost/perm_11.pdf

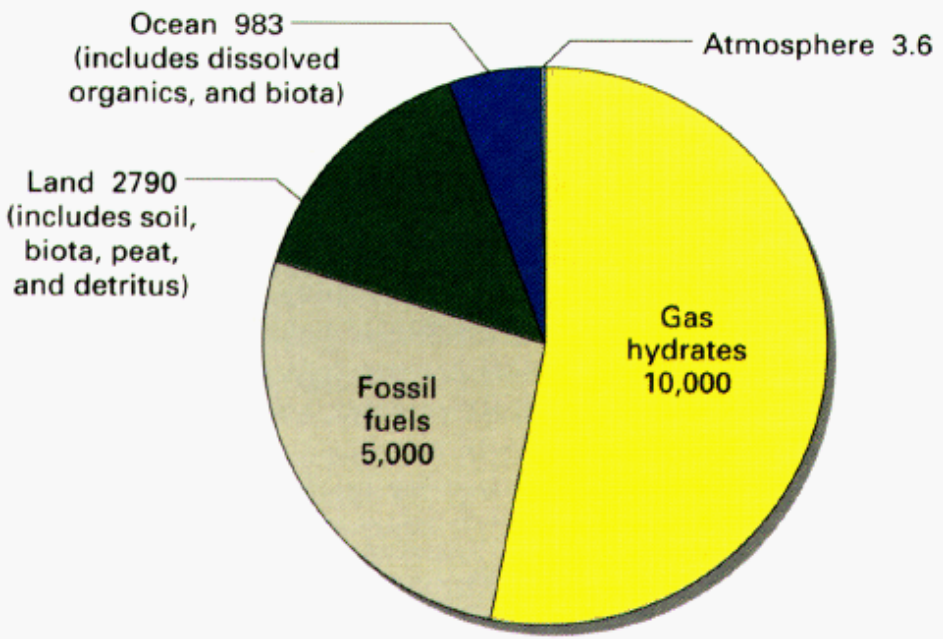
Průzkum a těžba



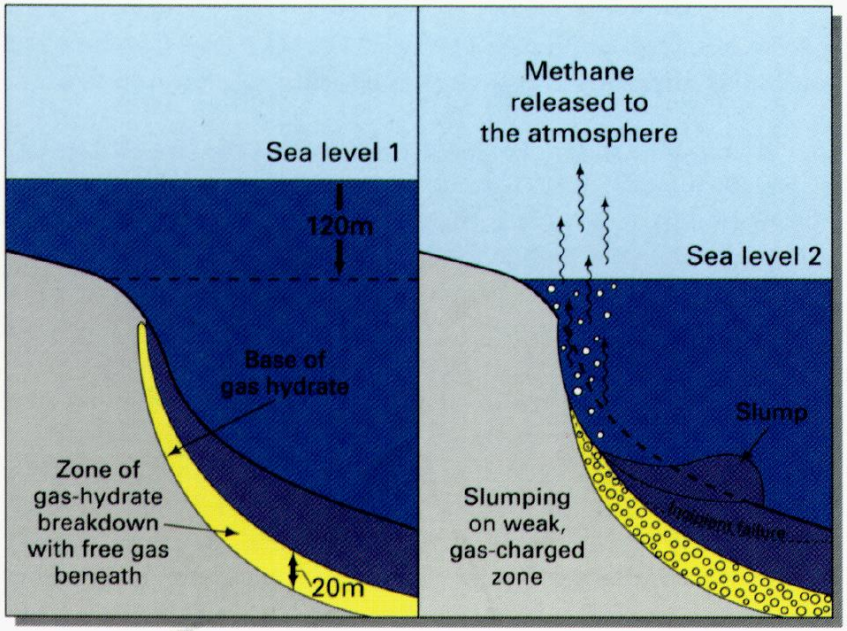


Význam hydrátů metanu

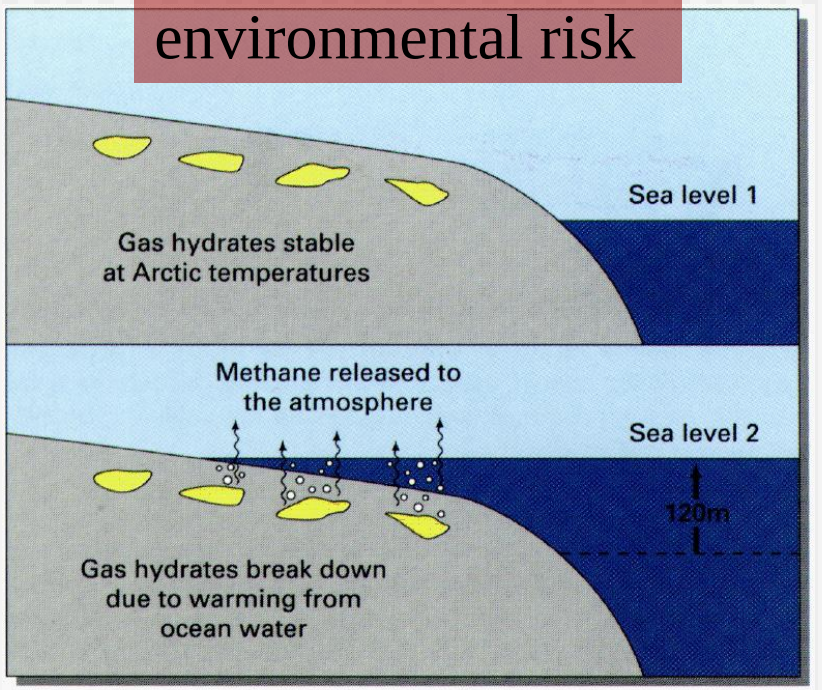
fossil fuels reserves



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.