

Průmysl stavebních a chemických surovin a jejich zdroje

nerostné zdroje světa

další čtení:

Havelka J. (1989): Ložiska rudních a nerudních surovin. VŠB, Ostrava.

<http://geologie.vsb.cz/loziska/loziska/>

Luke L.Y. Chang (2002): Industrial mineralogy. Materials, processes and uses. Prentice Hall.

Kužvart M.: Ložiska nerud, Ložiska nerudních surovin

Stavební a chemické suroviny

Fertilizers and chemical industrial minerals:

limestone, dolomite, lime

phosphate, salt, potash, sulfur, N and N-comp.,

další minerály pro zemědělství a chem.prům.: fluorit, glaukonit,

Construction and manufacturing industrial minerals:

cement, aggregate – crushed stone, sand, gravel, dimension stone, gypsum

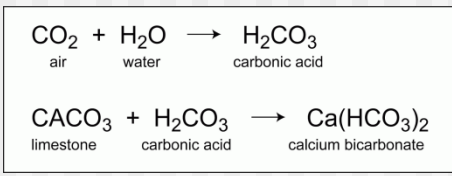
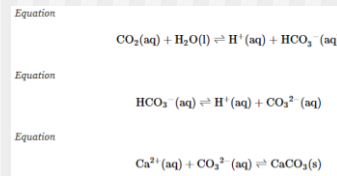
Fillers, extenders, pigments, filters:

clays, asbestos, diatomite, talc + pyrophyllite, barite, mica, zeolites, mineral pigments

Abrasive and refractory minerals:

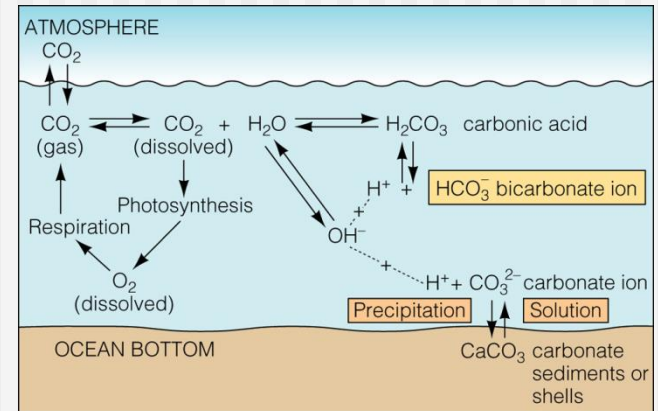
diamonds, other

graphite, kyanite, staurolite ...

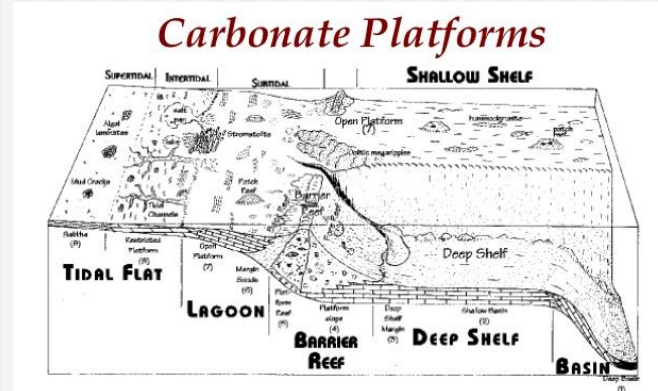


Vápence, dolomity, vápno

- vápence – CaCO_3
- dolomity – $\text{CaMg}(\text{CO}_3)_2$
- slínovce
- CCD – carb. compenzation depth, dnes pod cca 4300m se netvoří vápence
- CaO – vápno, z vápenců, celková produkce má vysokou hodnotu – spotřeba velkého množství energie
- použití: čištění vody, výroba oceli, odsíření, sklo, keramika, plnivo, zemědělství
- vápence: výroba cementu



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Carbonate platforms consist of thick accumulations of shallow water carbonate sediment separated into a number of zones based on water depth and energy conditions. As carbonates build to sea-level, platform tops tend to be very flat.

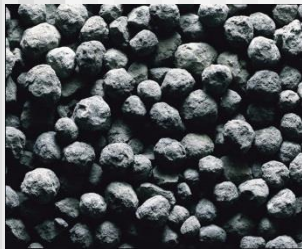
Cement production

Rank	Country	Capacity (Mt)
1	China	1452
2	India	301
3	USA (inc. Puerto Rico)	114
4	Turkey	82
5	Russia	80
6	Vietnam	73
7	Iran	71
8	Japan	70
9	Brazil	69
10	Pakistan	65

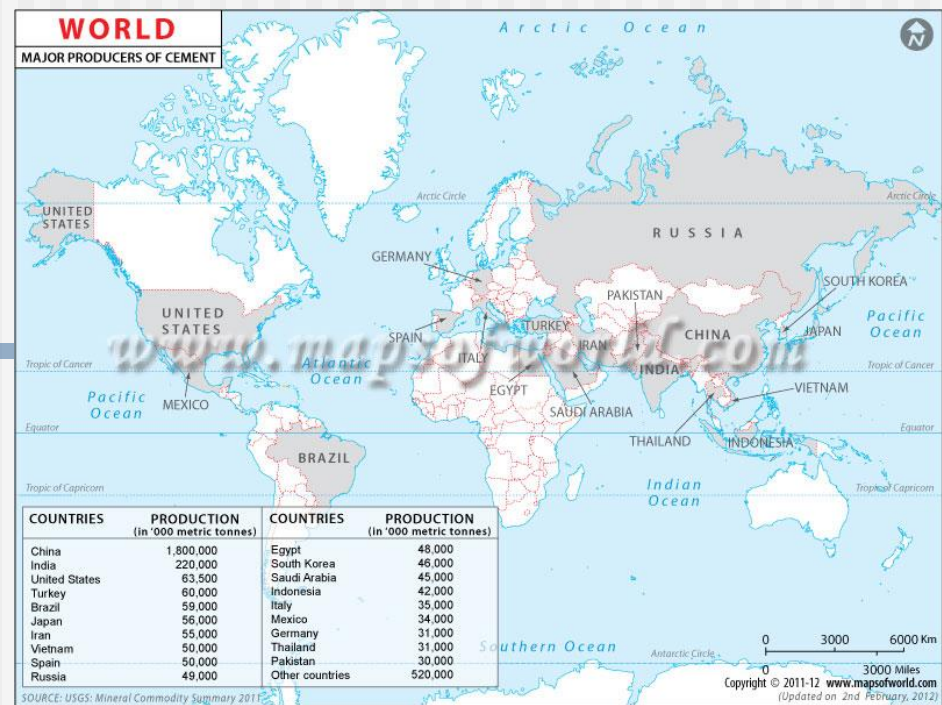
Rank	Company/Group	Country	Capacity (Mt/yr)	No. of plants
1	Lafarge	France	225	166
2	Holcim	Switzerland	217	149
3	CNBM	China	200	69
4	Anhui Conch	China	180	34
5	HeidelbergCement	Germany	118	71
6	Jidong	China	100	100
7	Cemex	Mexico	96	61

Above - Table 2: Top 10 global cement producing countries by installed capacity.
Source: USGS Mineral Programme Report 2011.

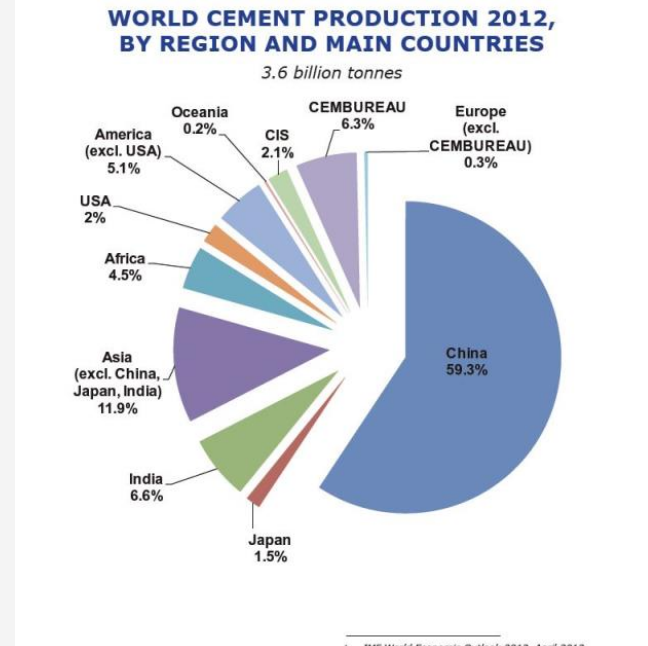
Cement



slínek (clinker)

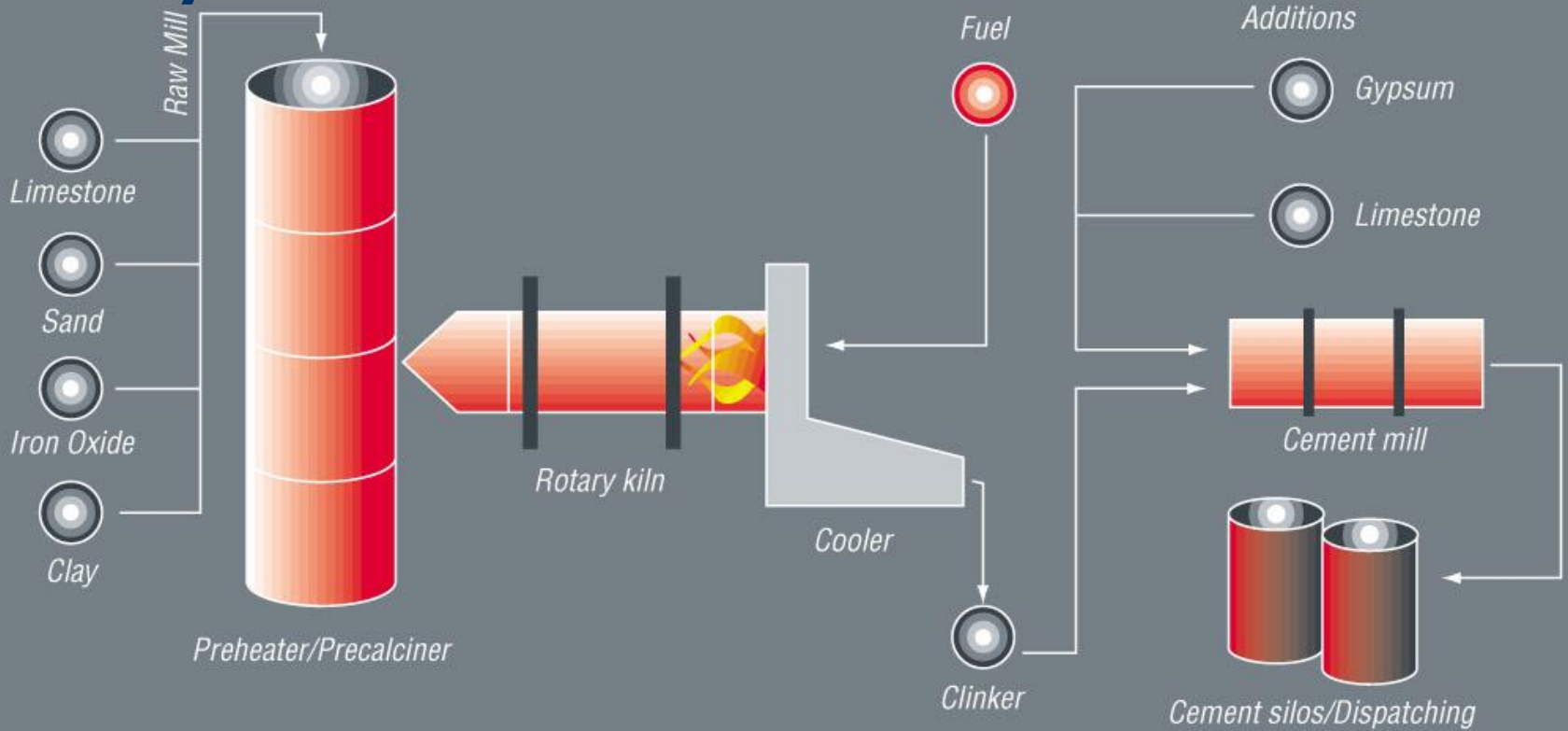


Country	1999	2000	2001	2002	2003 ^e
Total	1 600 000	1 660 000	1 730 000	1 840 000	1 950 000
1 China	573 000	597 000	661 040	725 000	813 190
2 India ^c	90 000	95 000	100 000	102 000	110 000
3 United States, including Puer	87 777	89 510	90 450	91 266	94 329
4 Japan	80 120	81 097	76 550	71 828	71 000
5 Korea, Republic of	48 157	51 255	52 046	55 514	59 199
6 Spain, including Canary Islan	35 782	38 115	40 512	42 500	42 000
7 Russia	28 400	32 400	35 300	37 700	41 000
8 Italy	37 299	38 925	39 804	40 000	38 000
9 Brazil	40 270	39 208	38 927	38 027	37 980
10 Indonesia	23 925	27 789	31 300	34 640	35 000
34 Belgium	7 277	7 150	7 500	8 000	8 000
47 Austria	3 817	3 776	3 863	3 800	3 800
52 Czech Republic	4 241	4 093	3 550	3 500	3 500
57 Slovakia	4 718	3 045	3 123	3 100	3 100



Dry process cement production

Výroba cementu



Raw material preparation

Clinker production

Cement production

Výroba vápna

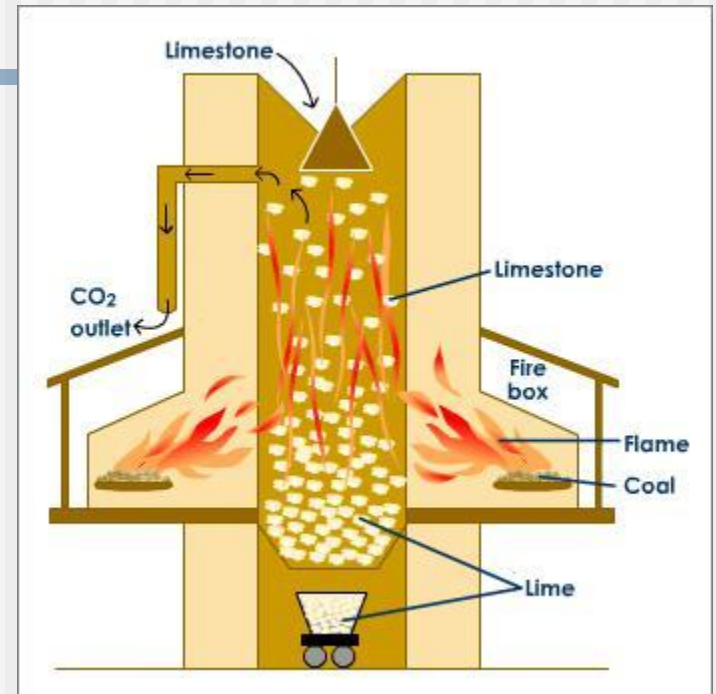
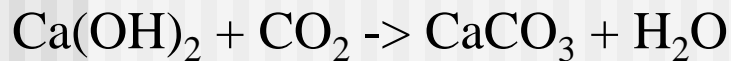
Pálení vápence probíhá při teplotě 900 - 1100°C podle následující rovnice:



Hašení vápna



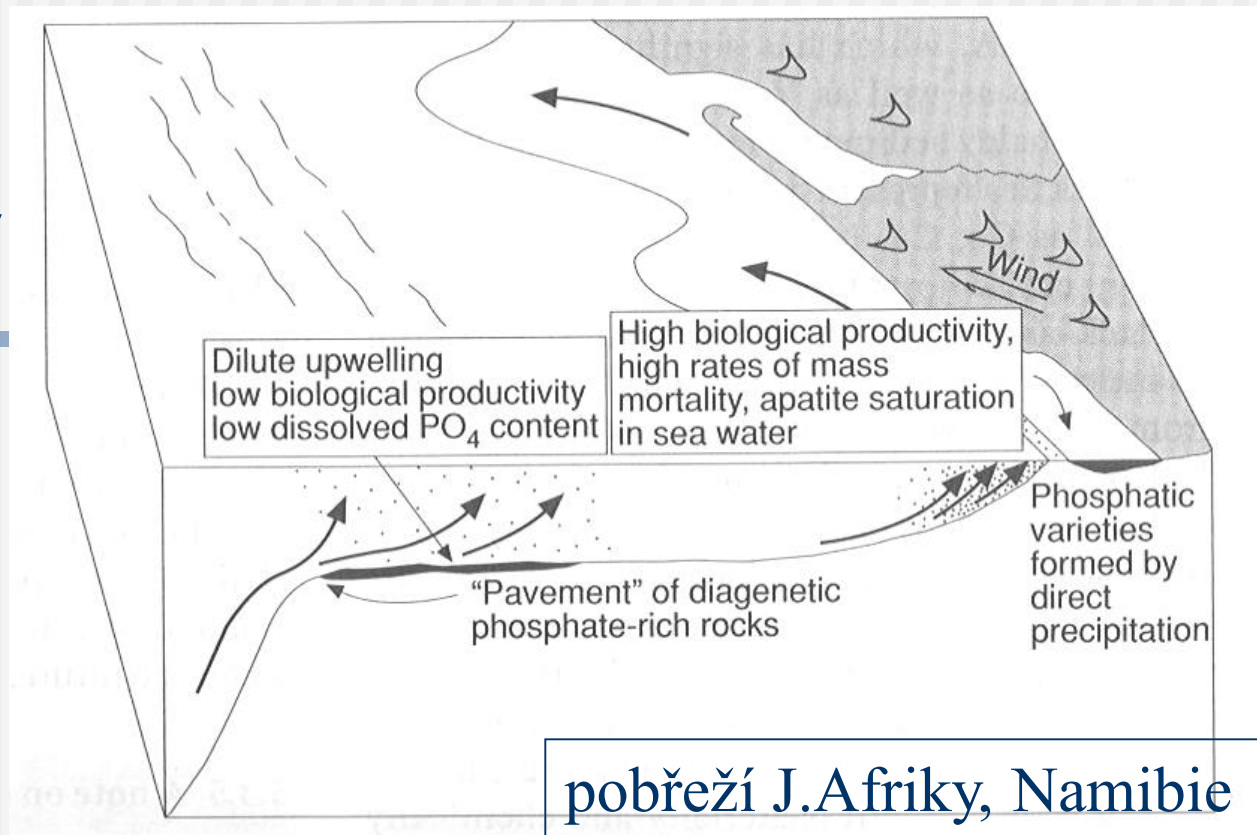
Tvrdnutí vápna



Ložiska karbonátů: v různých geologických útvarech (křída, ...), pasivní okraje kontinentů, šelfy

Producenti: Německo, Belgie, Francie, ČR, ... (Holcim, HeidelbergCement Group)

Fosfáty

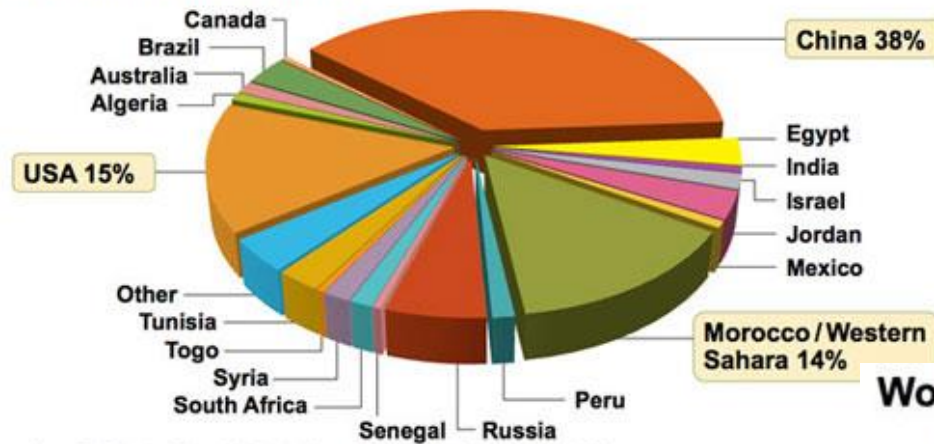


- ložiska magmatická – apatit $\text{Ca}_5(\text{PO}_4)_3(\text{OH}, \text{F}, \text{Cl})$: Chibinský komplex, karbonatity s apatitem – Afrika (Evate, Mosambik) ...
- ložiska sedimentární – fosfority (biochemická, biogenní)

zásoby: Montana, Utah – perm, Florida – miocén,
severní Afrika – Maroko: 250 km dlouhé pásmo, $\text{P}_2\text{O}_5 = 27-33 \%$

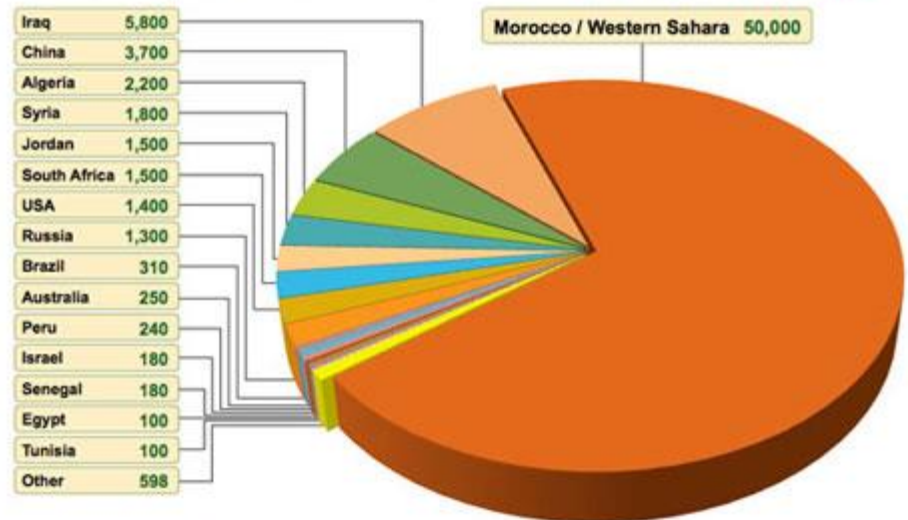
Phosphate production

World Phosphate Rock Concentrate Production
191 million tonnes/annum



Source: 2011 Production Estimate, U.S. Geological Survey, Mineral Commodity Summaries, January 2012

World Phosphate Rock Reserves 71,000 million tonnes*



* Source: 2011 Reserves, Millions of Metric Tonnes, U.S. Geological Survey, Mineral Commodity Summaries, January 2012



Halit, draselné soli

- minerály:
sylvín KCl
carnalit $\text{KCl} \cdot \text{MgCl}_2 \cdot 6\text{H}_2\text{O}$
kainit $\text{KCl} \cdot \text{MgSO}_4 \cdot 3\text{H}_2\text{O}$
- polyhalit, epsomit,
- produkce: Kanada 26% těžby a téměř polovina zásob, Německo 17%, USA 6%, Izrael 4,9%, Rusko

Ložiska: evapority
(sedimentární chemická)

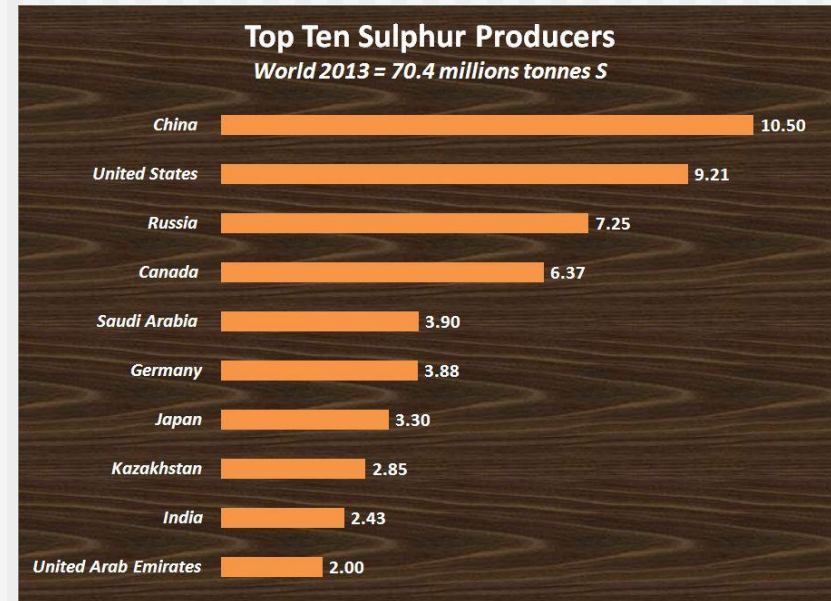
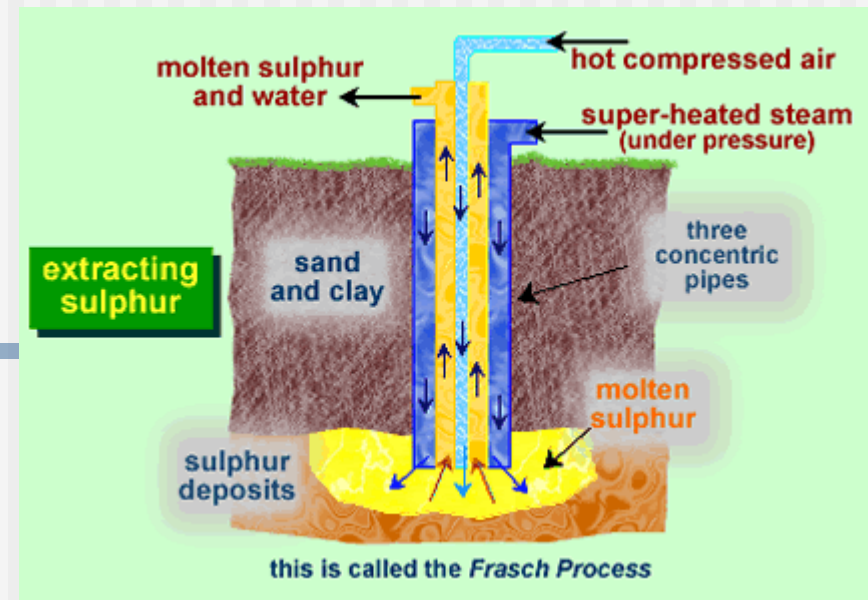
Síra



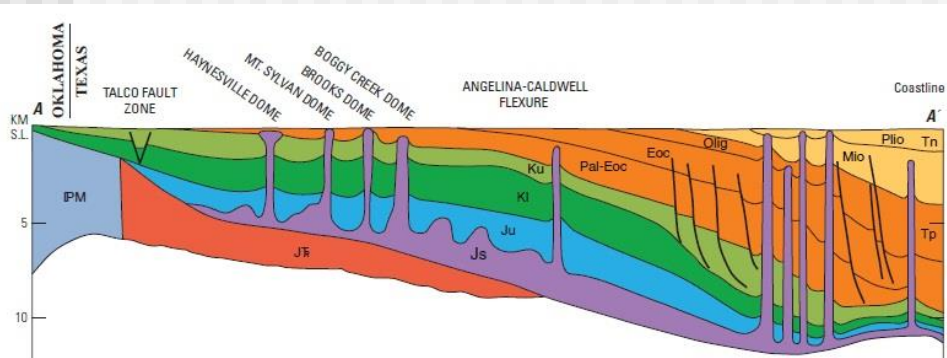
ložiska: infiltrační, biochemická, vulkanogenní, vznik při zpracování sulfidů, při úpravě zem. plynu a ropy

těžba: „Frasch method“ – vtlačení páry a rozpouštění síry

Hlavní producenti: země zpracovávající uhlovodíky a rudy (rafinace ropy, oxidace sulfidů) , těžba přírodních ložisek síry: Polsko, Indonésie, Texas

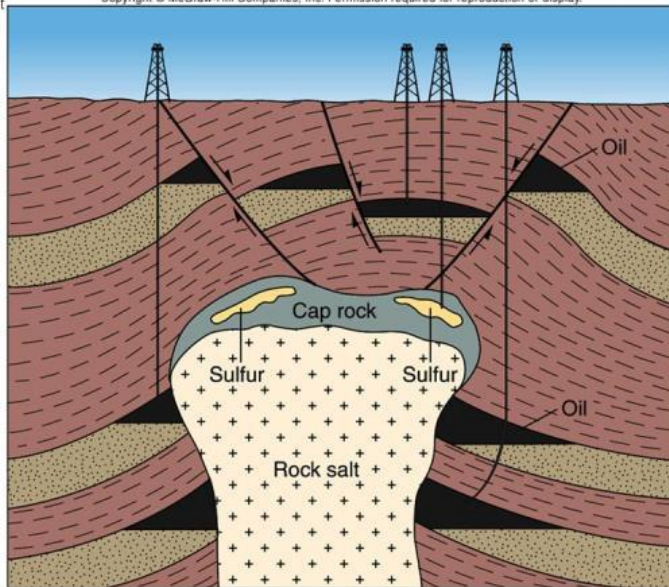


Texas – infiltrační ložiska síry



Oil Traps - Salt

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Kawah Ijen - síra



Indonesie, Jawa



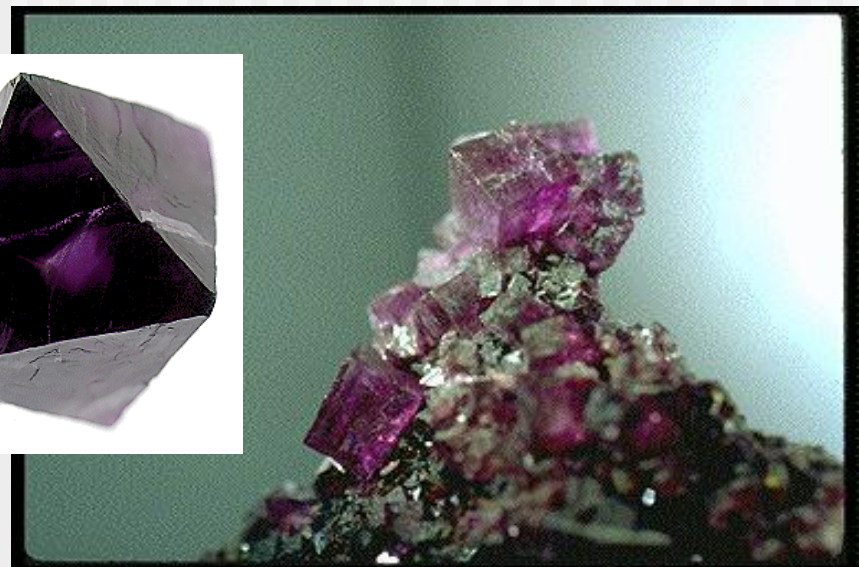
Fluorit – CaF_2

zdroje: hydrotermální ložiska
(Čína, Mongolsko, ..., ČR

použití:

metalurgie, HF,

UF_6 (obohacování uranu)



Drcené kamenivo, štěrk, písek

typická lokální surovina



tvár zrna důležitý, vyrábí se různé zrnitostní frakce: 0-4, 4-16, ...

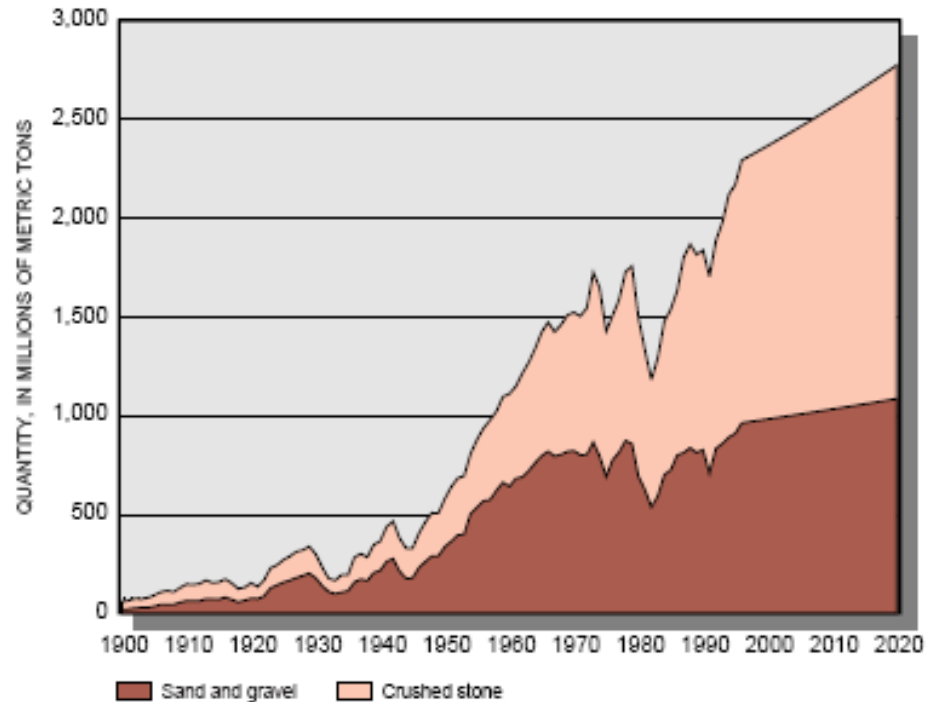


Těžba, třídění



National aggregates production in the United States with projections to 2020, based on growth rate of 1.0% for stone and 0.5% for sand and gravel.

Credit: U.S. Geological Survey



úprava na ložisku

Aerial view of the Suzio York Hill crushed stone quarry located near Meriden, Conn.

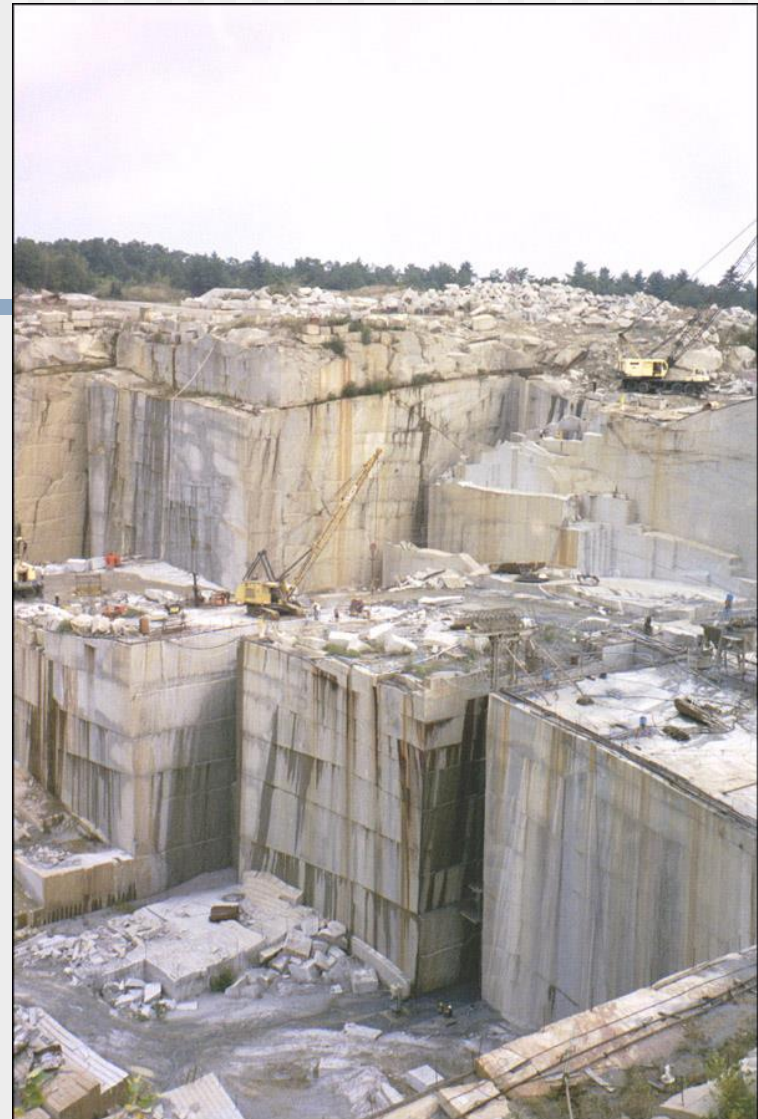
Credit: U.S. Geological Survey



Stavební kámen

dimension stone

- vlastnosti: neztvrdlé
horniny, nízká nasákavost,
leštitelnost, pevnost
- normy



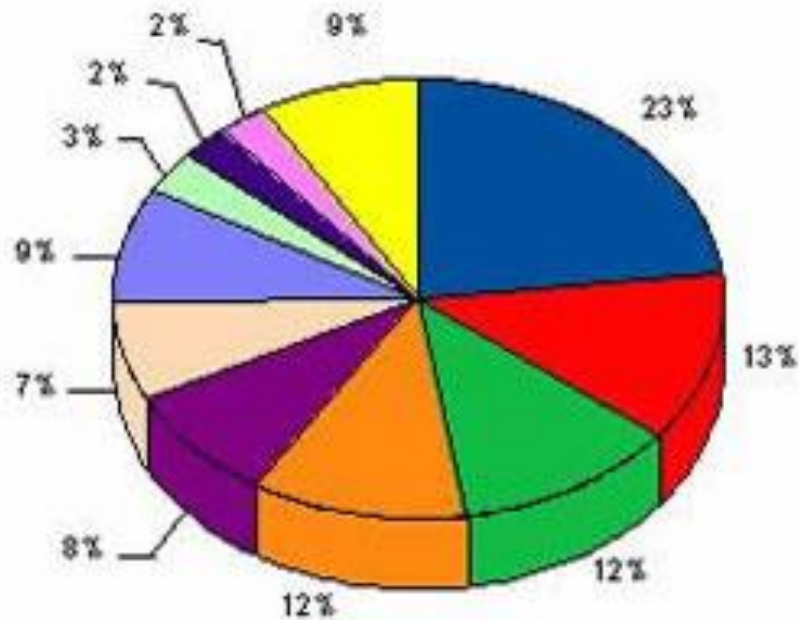
Produkce

World Dimension Stone Production, 2004



000 tonnes

China	20 600
India	11 200
Italy	10 580
Iran	10 400
Spain	7 600
Brazil	6 400
Turkey	7 720
Portugal	2 830
Egypt	2 200
Greece	2 100
Others	7 820



Sádrovec

Hlavní producenti (rok 1998):

USA 18,3 %

Írán 9,6 %

Thajsko 9,2 %

Kanada 9,2 %

Španělsko 8,9 %

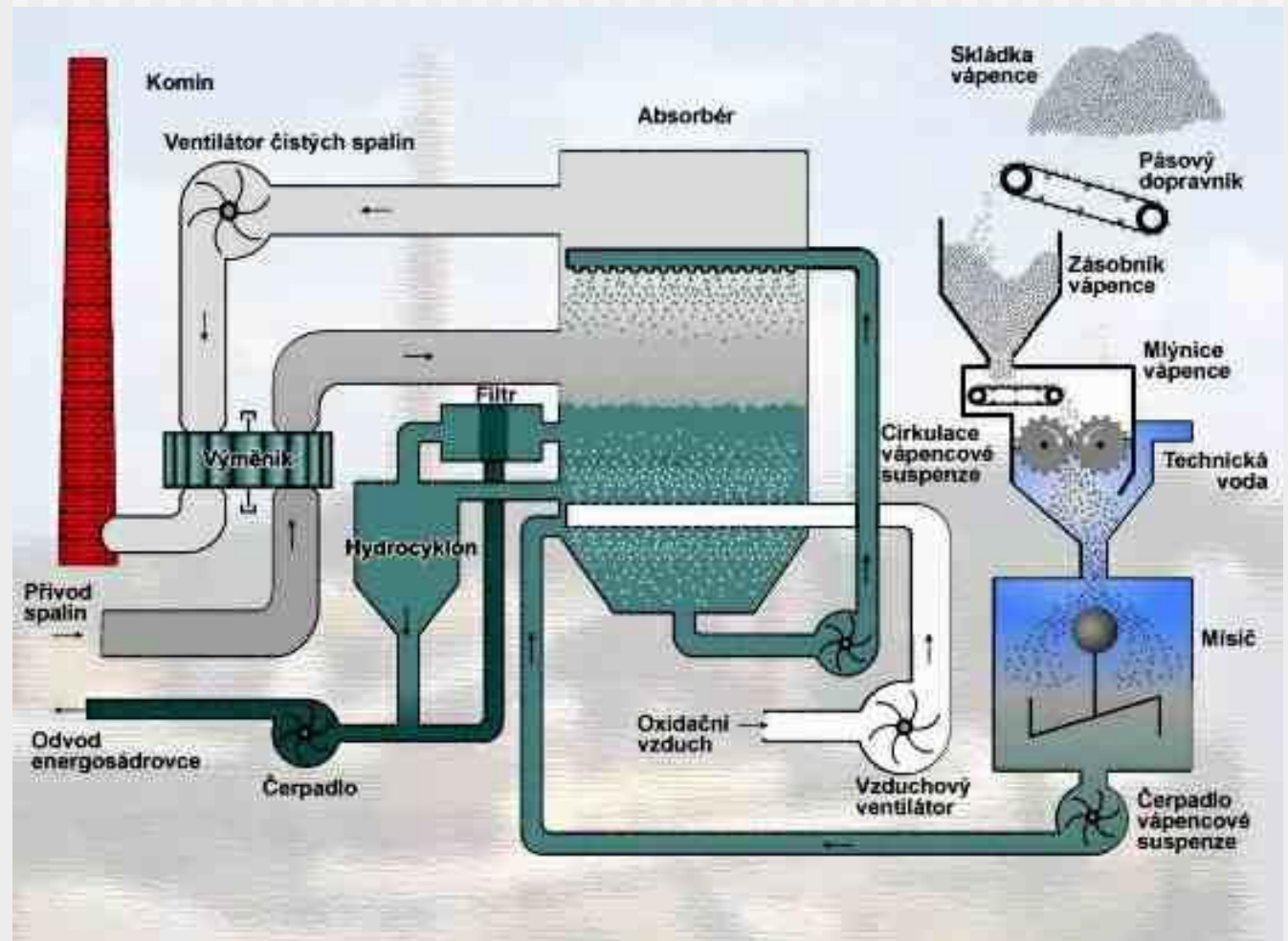
Čína 7,9 %

zdroje:

1) evapority

2) odsíření elektráren

Odsíření – zdroj sádrovce



Jíly

sedimentární a reziduální
ložiska

jíly – žáruvzdorné (vysoký obsah kaolinitu), keramické

montmorillonitové jíly (bentonit)

kaolín – reziduální ložiska

„kaolínové pásmo“: Georgia, Alabama
Anglie: Cornwall, Devon

Asbesty

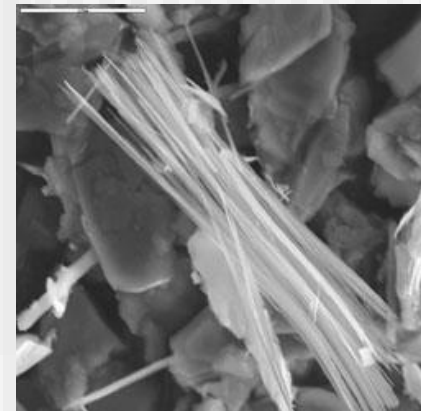
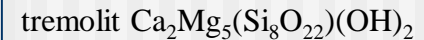


chrysotil



Chrysotile and asbestos amphiboles : two different fibre types

Chrysotile comes from the serpentine group, whereas the other fibre types, tremolite, amosite, crocidolite, actinolite and anthophyllite, are part of the amphiboles group. All these fibres are non-flammable. The major difference between chrysotile and amphiboles is related to its chemical composition, its acid-resistant properties and its effects on health. In contrast with amphiboles, Chrysotile does not persist in the lungs after inhalation; it is quickly eliminated by the body. A prolonged exposure to high concentrations of chrysotile fibres is required for a clinical manifestation of pulmonary damage to appear. In the past, such high exposures were frequent; it is no longer the case today. On the other hand, because of their toxicity and their high biopersistence, amphiboles are mainly responsible for mesothelioma and pulmonary deceases even caused after a short or moderate exposure. Today, **chrysotile** is the only asbestos fibre commercialized.



Asbest - produkcce

World production

Estimated production (tonnes) for 1999

Russia 870 000

China 360 000

Canada 220 000

Brazil 210 000

Kazakhstan 200 000

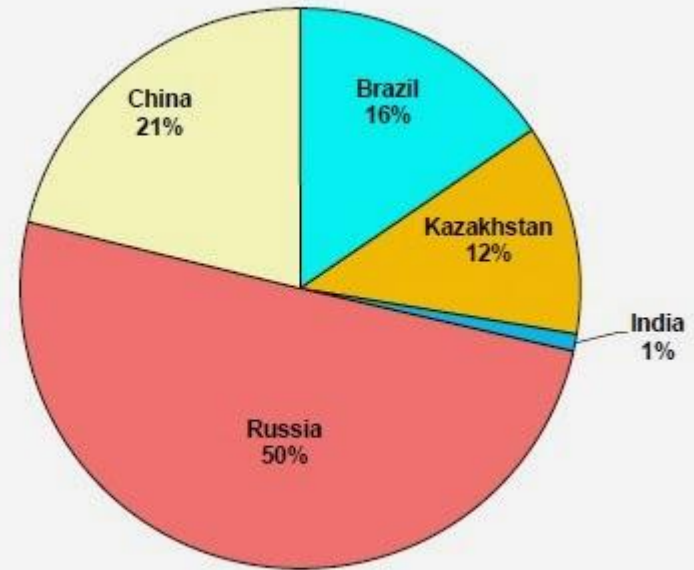
Zimbabwe 170 000

Other 50 000

Total 2 080 000

Sources: Natural Resources Canada, U.S. Geological Survey, The Chrysotile Institute

Global Asbestos Fiber Production, 2012



Source: International Ban Asbestos Secretariat & Citi Research

World consumption

Estimated consumption (tonnes) for 2003

Far East 880 000

Russia and Central Asia 530 000

Middle East and Indian sub-continent 320 000

Africa 80 000

Central and South America 180 000

North America 50 000

Europe 40 000

Total 2 080 000

Source: The Chrysotile Institute

Těžba v Brazílii

Cana Brava - Brazílie

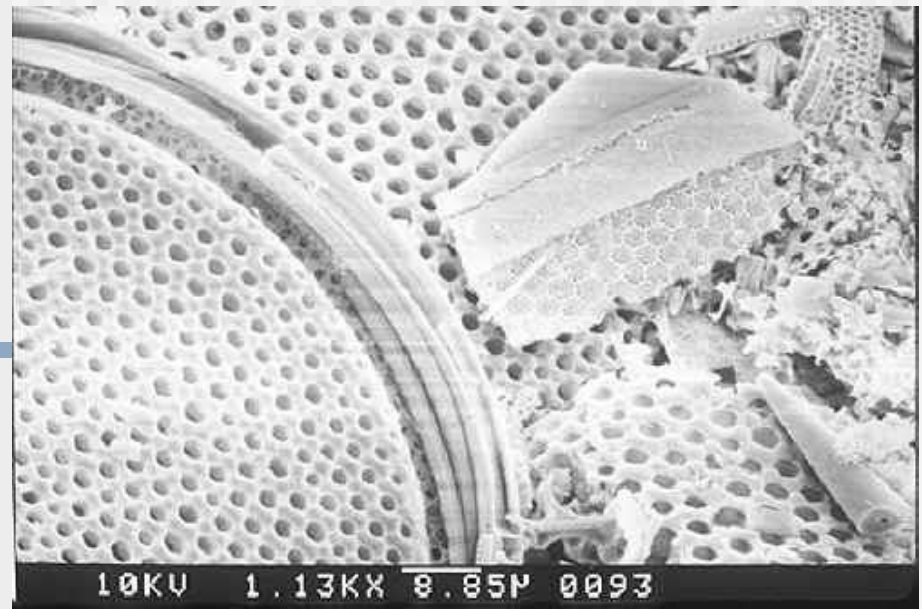
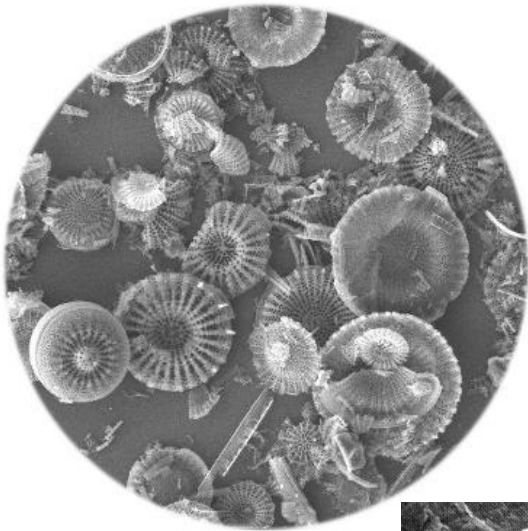


Kanada

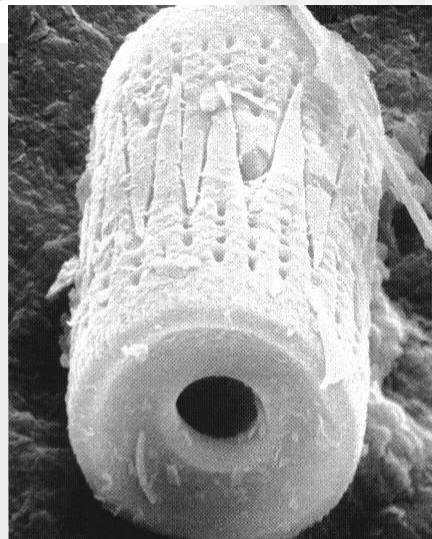
LAB Chrysotile Inc. - Canada



Diatomit



A scanning electron microscope image of diatom skeletons clearly showing their porous nature (image by Dr. Rick Behl).



Diatomit - použití

USES

Oil, water and chemical absorbent

Pet litter

Fertiliser (anti-caking) agent

Pesticide manufacturing

Horticultural potting mix and soil conditioner

Hydroponic medium

Agricultural chemical carrier

Dessicant

Filtration for food and beverage manufacturing

Swimming pool filtration

Filler for paint/rubber/plastics

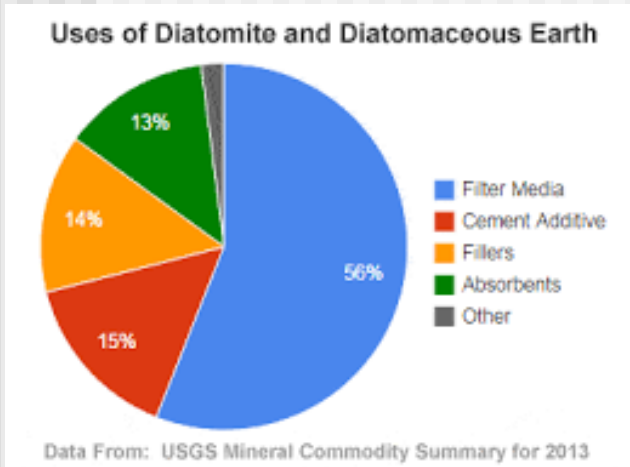
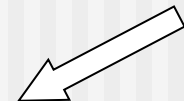
Lightweight building material

Cement and concrete additive

Refractory

Mild abrasive

puzzolanic reactions



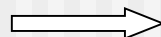
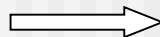
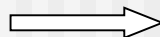
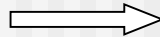
kys.ortokřemičitá, zastupuje koloidní roztok



DIATOMITE: WORLD PRODUCTION, BY COUNTRY ^{1,2}

(Thousand metric tons)

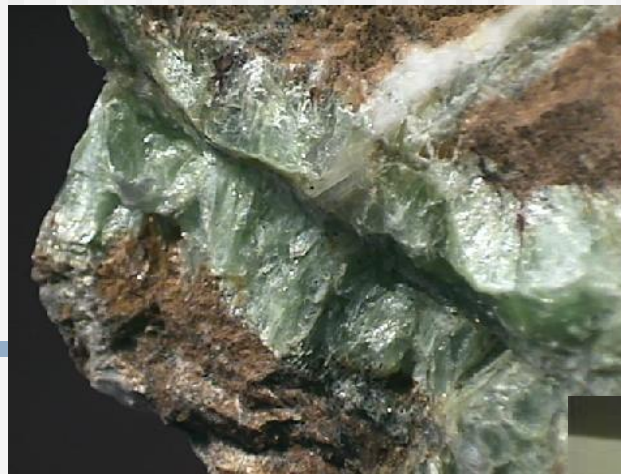
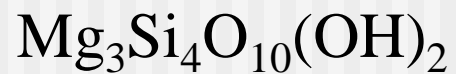
Diatomit



Country	1999	2000	2001	2002	2003 ^e
Algeria	3	3 ^e	3	3	3
Argentina	34 ^r	18 ^r	28 ^r	23 ^r	20
Australia ^e	20	20	20	20	20
Brazil, marketable ^e	13 ^r	13 ^r	13 ^r	13 ^r	13
Chile	14	13	23	30 ^r	30
China ^e	340	350	350	370	380
Colombia ^e	4	4	4	4	4
Commonwealth of Independent States ^{e, 3}	80	80	80	80	80
Costa Rica	18	35	26	26	25
Czech Republic	37	34	83 ^r	28 ^r	30
Denmark ^{e, 4}	185	234 ^r	231 ^r	231 ^r	232
France ^e	80	75	75	75	75
Iceland	28	28	30 ^r	31 ^{r, e}	30
Iran ^{e, 5}	4 ⁶	5	5	5	5
Italy ^e	25	25	25	25	25
Japan ^e	190	190	180 ^r	180 ^r	180
Kenya	1 ^r	(7) ^r	(7) ^r	1 ^r	1
Korea, Republic of	30	34	28	21 ^r	21
Macedonia ^e	5 ^r	5	5	5	5
Mexico	65	96	69	62 ^r	60
Peru ^e	35	35	35	35	35
Poland	1	1	1	1	1
Portugal ^e	2	2	2	2	2
Romania	12	9	10 ^r	20 ^r	20
Spain ^{e, 8}	36	35	35	35	35
Thailand	2	(7)	1 ^r	1 ^r	1
United States ⁹	747	677	644	624	620 ⁶
Total	2 010 ^r	2 020 ^r	2 010 ^r	1 950 ^r	1 950

^eEstimated. ^rRevised.¹World totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown. Purity and moisture content are generally not reported or estimated.²Table includes data available through April 4, 2004.³Information is inadequate for formulation of reliable estimates for individual countries.⁴Data represent "extracted moler" (reported cubic meters times 1.5). Contains about 30% clay.⁵Data are for Iranian years beginning March 21 of that stated.⁶Reported figure.⁷Less than 1/2 unit.⁸Includes tripoli.⁹Sold or used by producers.

Mastek a pyrofylyt



Mastek, pyrofylit - použití

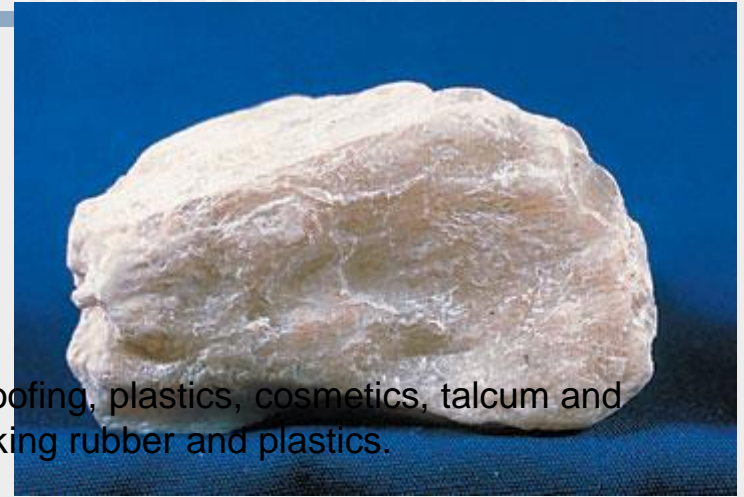
plniva (fillers)

Uses

Ground talc is used as an ingredient in ceramics, paper, paint, roofing, plastics, cosmetics, talcum and baby powders, and a variety of other assorted uses such as making rubber and plastics.

Ground pyrophyllite is used in the production of ceramics, heat-resistant products called *fractories*, and paint.

Soapstone was once used to make chemical-resistant sinks and countertops for laboratories. Before the days of furnaces, blocks of soapstone were heated on stoves and used as bed warmers.



zdroje: metasomatická přeměna magnezitu, dolomitu, metamorfně-hydrotermální žíly v ultra- a bazických horninách USA, Indie (velmi čistý), Čína, Rusko, Evropa

Baryt

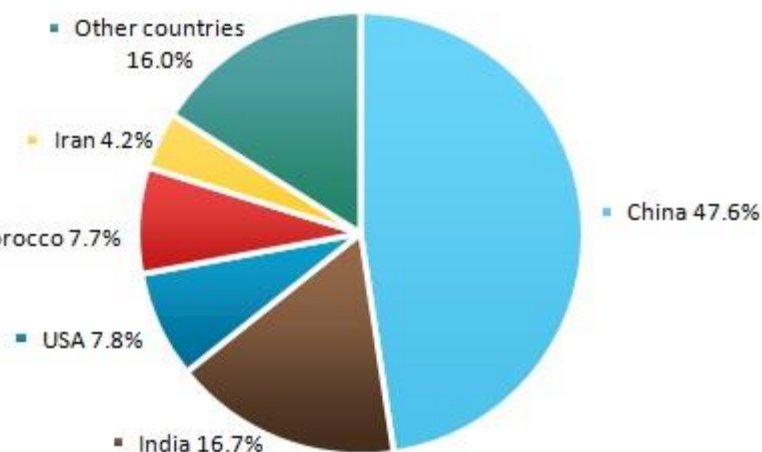


zdroje: hydrotermální ložiska

Baryt

Country	1999	2000	2001	2002	2003 ^e
China ^c	3 500 000	3 500 000	3 600 000	3 100 000	3 500 000
India	360 000	840 000	850 000	600 000	700 000
United States ⁸	434 000	392 000	400 000	420 000	468 000
Morocco	328 945	343 557	471 102	469 934	356 394
Mexico	157 953	127 420	142 017	163 620	255 961
Iran ³	183 850	185 000	195 539	179 652	150 000
Thailand	76 092	56 180	23 559	137 469	130 000
Germany, marketable Ba ₂ SO ₄ ^c	120 000	120 000	120 000	120 000	120 000
Turkey, run of mine	150 058	120 893	53 373	106 843	110 000
Bulgaria ^{c, 6}	120 000	120 000	100 000	90 000	75 000
France	75 000	75 000	75 000	75 000	75 000
Korea, North ^c	70 000	70 000	70 000	70 000	70 000
Russia ^c	60 000	60 000	60 000	60 000	60 000
United Kingdom	59 000	55 000	60 000	60 000	60 000
Brazil, beneficiated	44 906	53 741	54 790	54 895	55 000
Algeria	50 150	51 925	43 020	51 733	49 995
Kazakhstan ⁵	13 300	14 000	45 000	46 000	40 000
Belgium ^c	30 000	30 000	30 000	30 000	30 000
Spain, marketable Ba ₂ SO ₄	26 000	26 000	26 000	26 000	26 000
Italy ^c	25 000	25 000	25 000	25 000	25 000
Pakistan	20 505	21 234	22 000	25 000	25 000
Canada	123 000	67 000	23 000	19 000	23 000
Australia ^c	18 000	20 000	20 000	--	20 000
Burma	24 651	30 370	--	18 000	20 000
Georgia ^c	15 000	15 000	15 000	15 000	15 000
Slovakia, concentrate	16 000	14 000	14 000	11 000	14 000
Total world	6 160 000	6 490 000	6 590 000	6 020 000	6 520 000

Global Barite Production in 2012



produkce ve světě v tunách

Zeolity



natrolit –
 $\text{Na}_2\text{Al}_2\text{Si}_3\text{O}_{10} \cdot 2\text{H}_2\text{O}$



chabazit



phillipsit -
 $\text{KCaAl}_3\text{Si}_5\text{O}_{16} \cdot 6\text{H}_2\text{O}$



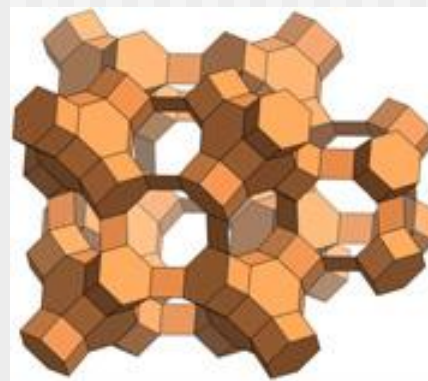
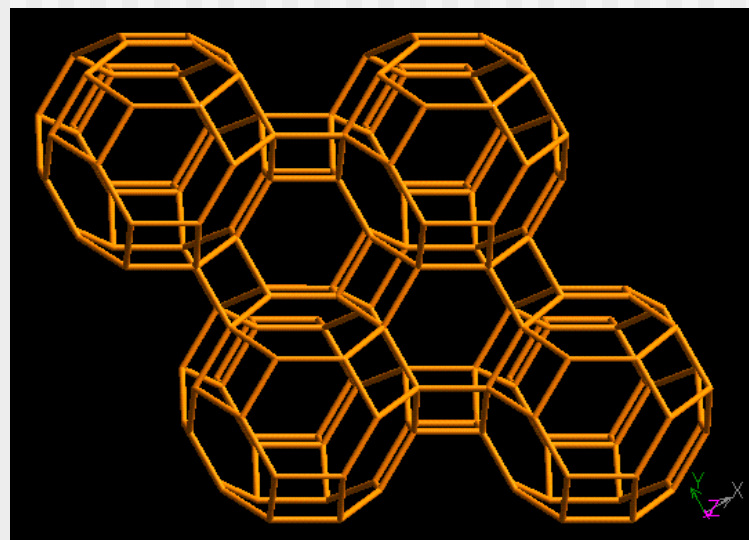
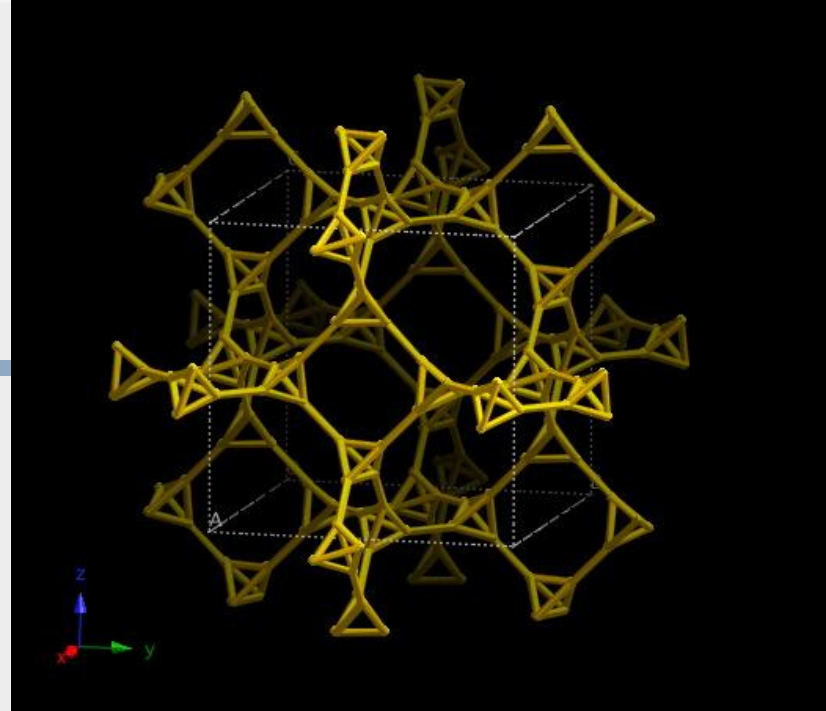
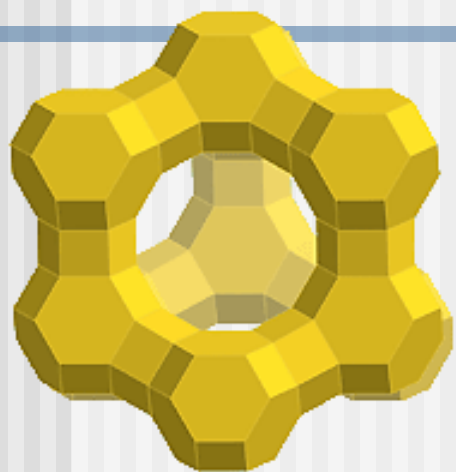
klinoptylolit



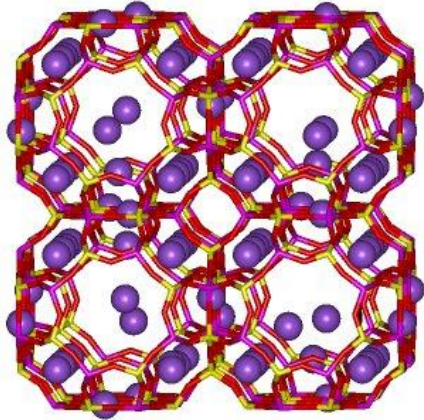
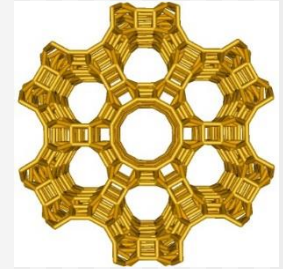
stilbit

zdroje: hydrotermální přeměna vulk.skěl,
sedimentární a diagenetické procesy,
John Day Formation (Oregon) - USA, Maďarsko,
Japonsko, Kuba, Itálie

Struktury zeolitů



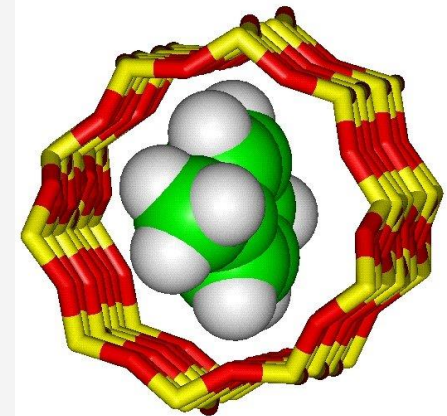
Zeolity - využití



Sodium Zeolite A, used as a water softener in detergent powder

Ion Exchange

The loosely-bound nature of extra-framework metal ions (such as in zeolite NaA, right) means that they are often readily exchanged for other types of metal when in aqueous solution. This is exploited in a major way in water softening, where alkali metals such as sodium or potassium prefer to exchange out of the zeolite, being replaced by the "hard" calcium and magnesium ions from the water. Many commercial washing powders thus contain substantial amounts of zeolite. Commercial waste water containing heavy metals, and nuclear effluents containing radioactive isotopes can also be cleaned up using such zeolites.



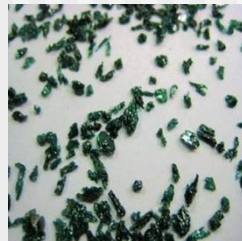
The shape of para-xylene means that it can diffuse freely in the channels of silicalite

Adsorption and Separation

The shape-selective properties of zeolites are also the basis for their use in molecular adsorption. The ability preferentially to adsorb certain molecules, while excluding others, has opened up a wide range of molecular sieving applications. Sometimes it is simply a matter of the size and shape of pores controlling access into the zeolite. In other cases different types of molecule enter the zeolite, but some diffuse through the channels more quickly, leaving others stuck behind, as in the purification of *para*-xylene by silicalite.

Abrazíva

- „high grade“: diamant, korund, granát,
- silikátová (kvarcity, silicity, křemen, diatomit, pemza)
- ostatní (bauxit, magnezit, živec, křída, kaolín, mastek, SiC,



Green Silicon Carbide



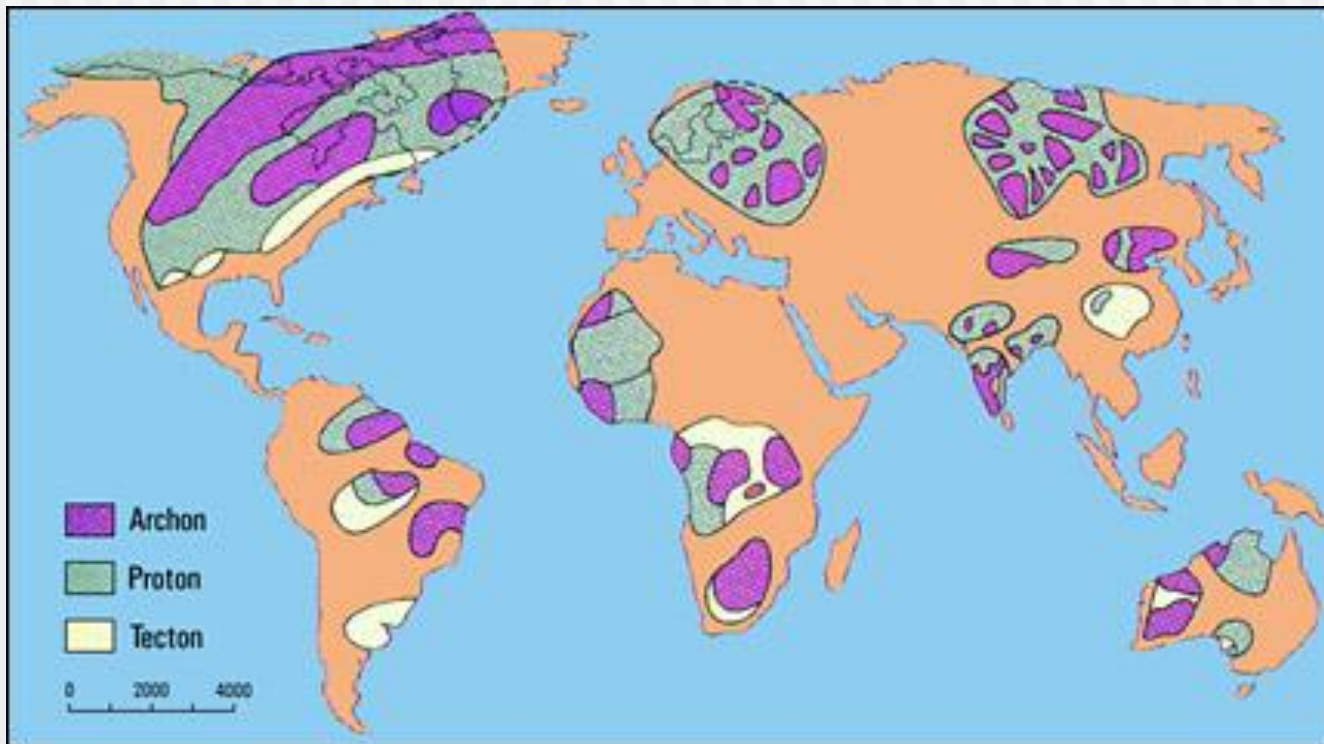
Diamanty

nejproduktivnější ložisko
Argyle, Austrálie



Nejhlubší povrchový důl na diamanty
Big Hole v Kimberly

Diamantonosné terény



Mapa distribuce ložisek diamantů (Levinson et al., 1992).

Těžba diamantů



mine de Jwaneng (kimberlite;
Botswana)

Argyle, Austrálie



Země	Karáty (v tisících)	Cena (\$ m)
Angola	5871	803
Austrálie	26070	294
Botswana	26416	2194
Brazílie	550	22
Čína	150	15
Ghana	450	11
Guinea	754	128
Jižní Afrika	11301	1145
Kanada	3685	531
Kongo	19637	496
Namíbie	1502	322
Rusko	20500	165
Sierra Leone	375	68
Tanzánie	191	28
Venezuela	325	41
Celkově	110176	7253

Diamanty – ložiska ve světě

