

8. ZEMNOALKALIJSKI METALI

1																	18
2																	
3																	
4																	
5																	
6																	
7																	

4 Be
12 Mg
20 Ca
38 Sr
56 Ba
88 Ra

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sciencememes.org

	Be	Mg	Ca	Sr	Ba	Rn.
Zastup. %	$6 \cdot 10^{-4}$	2,09	3,63	0,015	0,040	10^{-10}
Gustoća gcm^{-3}	1,845	1,74	1,54	2,6	3,5	5,5
T.T. (°C)	1284	651	851	770	710	700
T.V. (°C)	2507	1103	1440	1380	1500	1140
E_i (kJ/mol)	900(I) 1757(II)	738(I) 1450(II)	590(I) 1145(II)	549(I) 1064(II)	503(I) 965(II)	509(I) 975(II)
Atomski radijus (Å)	1,11	1,60	1,97	2,15	2,17	2,23
Ionski radijus (Å)	0,27 (K.B.=4) 0,41 (K.B.=6)	0,57 (K.B.=4) 0,86 (K.B.=6)	1,00 (K.B.=6) 1,14 (K.B.=8)	1,18 (K.B.=6) 1,32 (K.B.=8)	1,35 (K.B.=6) 1,49 (K.B.=8)	1,48 (K.B.=8) 1,70 (K.B.=12)

	Li	Na	K	Rb	Cs
Zastup. %	0,0065	2,83	2,59	0,028	$3,2 \cdot 10^{-4}$
Gustoća gcm^{-3}	0,534	0,97	0,87	1,53	1,873
T.T. (°C)	180,5	97,8	63,7	38,5	28,5
T.V. (°C)	1326	883	756	688	690
E_i (kJ/mol)	520,1(I) 7296(II)	495,7(I) 4563(II)	418,7(I) 3069(II)	402,9(I) 2640(II)	375,6(I) 2260(II)
Elektronski afinitet (kJmol^{-1})	59,8	52,9	48,3	46,9	45,5
Elektroneg ativnost	0,98	0,93	0,82	0,82	0,79
Atomski radijus (Å)	1,52	1,85	2,31	2,46	2,63
Ionski radijus (Å)	0,74 (K.B.=6)	1,02 (K.B.=6)	1,38 (K.B.=6)	1,49 (K.B.=6)	1,70 (K.B.=8)

U vodenoj otopini

Svi osim Be reagiraju s vodom (ali manje burno od alkalijskih) $M(s) + H_2O(l) \rightarrow M(OH)_2 + H_2$

U vodenoj otopini kationi M^{2+} – jako slabo kiseli (osim Be)

Lakše rade komplekse od alkalijskih – pogotovo Be

Dobro topljive soli s nebazičnim anionima (slabije topljive kovalentnije soli lakših kationa), slabo topljive s bazičnijima (najslabije topljive soli slabije hidratiziranih težih kationa)

Npr, produkti topljivosti hidroksidâ i sulfatâ pri 25 °C :

$$K_{sp}(Be(OH)_2) = 1 \cdot 10^{-19} \text{ mol}^3 \text{ dm}^{-9}$$

$$K_{sp}(Mg(OH)_2) = 8,9 \cdot 10^{-12} \text{ mol}^3 \text{ dm}^{-9}$$

$$K_{sp}(Ca(OH)_2) = 1,3 \cdot 10^{-6} \text{ mol}^3 \text{ dm}^{-9}$$

$$K_{sp}(Sr(OH)_2) = 3,2 \cdot 10^{-4} \text{ mol}^3 \text{ dm}^{-9}$$

$$K_{sp}(Ba(OH)_2) = 5,0 \cdot 10^{-3} \text{ mol}^3 \text{ dm}^{-9}$$

$$K_{sp}(BeSO_4) = 1,5 \cdot 10^{-1} \text{ mol}^2 \text{ dm}^{-6}$$

$$K_{sp}(MgSO_4) = 6,7 \text{ mol}^2 \text{ dm}^{-6}$$

$$K_{sp}(CaSO_4) = 2,4 \cdot 10^{-5} \text{ mol}^2 \text{ dm}^{-6}$$

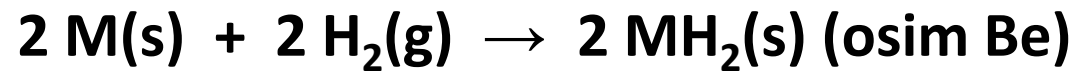
$$K_{sp}(SrSO_4) = 7,6 \cdot 10^{-7} \text{ mol}^2 \text{ dm}^{-6}$$

$$K_{sp}(BaSO_4) = 1,5 \cdot 10^{-9} \text{ mol}^2 \text{ dm}^{-6}$$

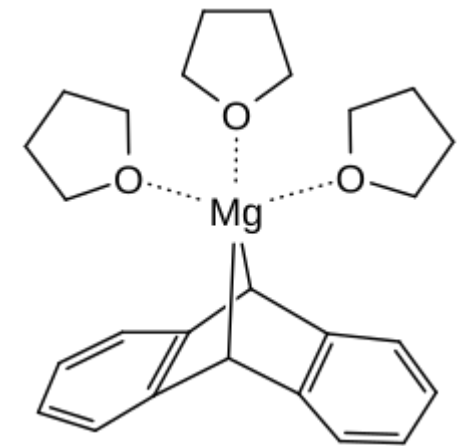
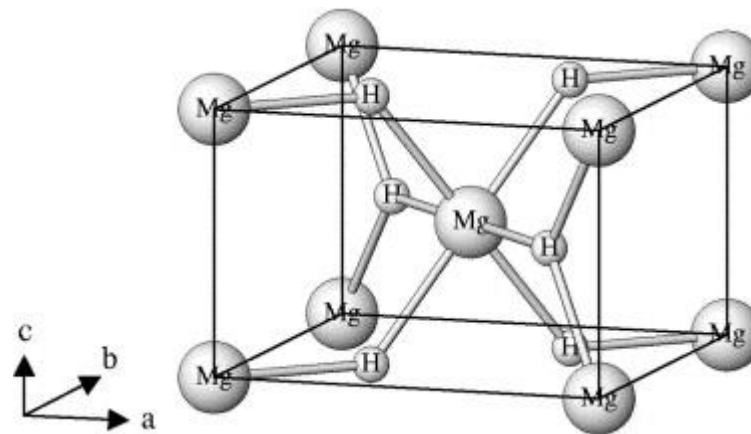
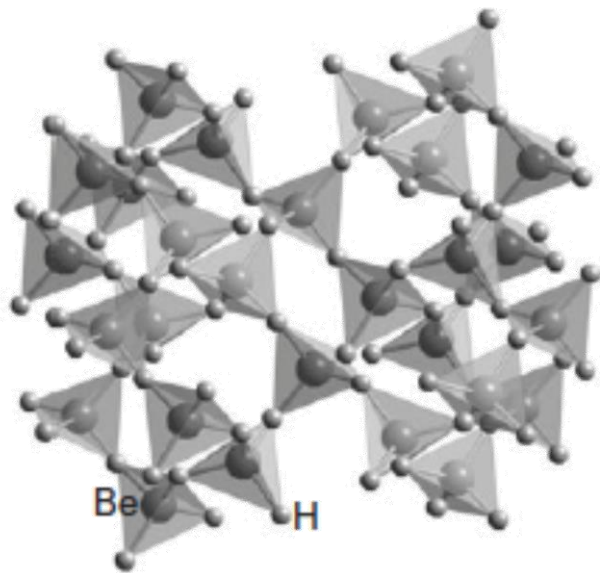
$$K_{sp}(RaSO_4) = 4,0 \cdot 10^{-11} \text{ mol}^2 \text{ dm}^{-6}$$

Halogenidi dobro topljivi, osim fluoridâ; karbonati i fosfati netopljiviji od sulfata

Soli često kristaliziraju kao hidrati.



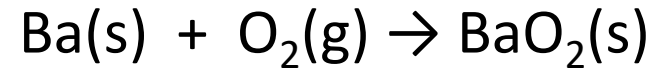
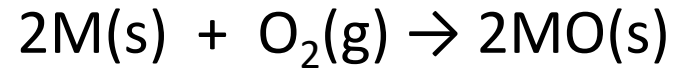
(MgH₂ lakše nastaje hidrogeniranjem „Mg-antracena“)



Mg-antracen

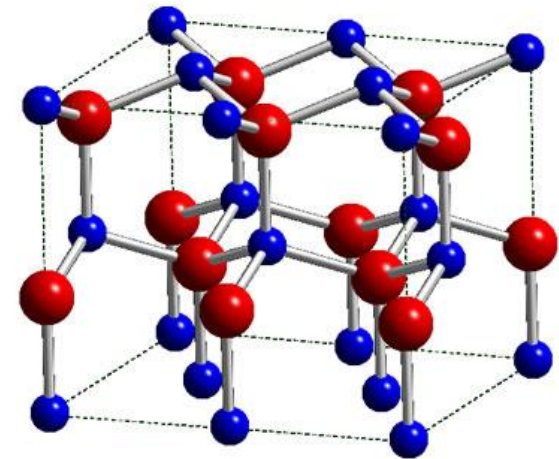
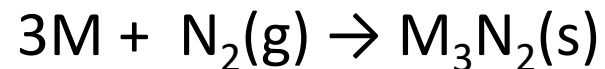


Reakcije s O₂



Oksidi – bazični (BeO amfoteran); stabilni na povišenim temperaturama; mogu se dobiti i termičkim raspadom karbonatâ; slaba topljivost u vodi; visoka tališta, kristaliziraju po tipu NaCl

Reakcije s N₂ (ili NH₃)

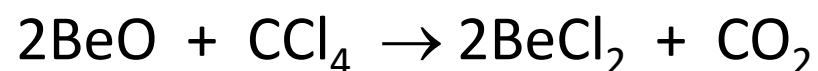


Reakcijom iz elemenata

Otapanjem metalâ, oksidâ, hidroksidâ i karbonatâ u kiselinama

Reakcijom karbonatâ s amonijevim halogenidima

berilijev klorid i karbotermijski om reakcijom BeO (s C i Cl₂) te



Neki mogu postojati kao hidrati, grijanjem gube vodu (bezvodni CaCl₂ kao sredstvo za sušenje – nastaju CaCl₂·*n*H₂O, *n* = 1, 2, 4, 6)

Svi ionski spojevi osim berilijevog klorida, bromida i jodida.

BERILIJ

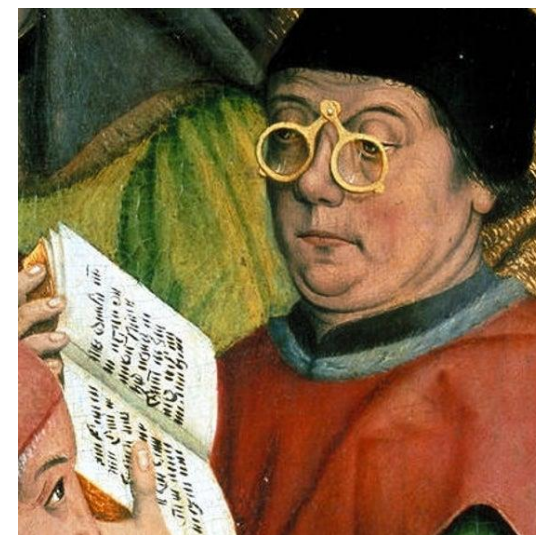
Od $\beta\acute{\eta}\rho\upsilon\lambda\lambda\omicron\varsigma$ = beril (mineral/drugi kamen, $\text{Be}_3\text{Al}_2\text{Si}_6\text{O}_{18}$; usp. njem *Brille*, vjerojatno od भिलर् (*vilar*) = problijediti)

L. N. Vauquelin, 1798 g. – beril i smaragd kemijski identični sadrže nepoznatu 'zemlju'

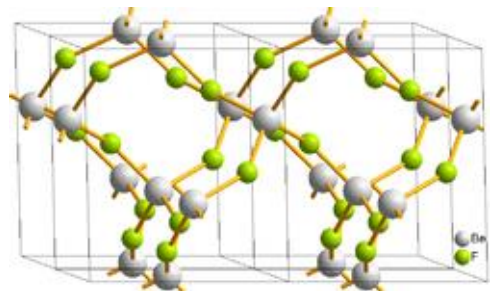
F. Wöhler, A. A. Bussy, 1822. izolirali metal

Prozori u izvorima zračenja (npr. rentgenske cijevi) i legure
Elektronika, nuklearni reaktori...

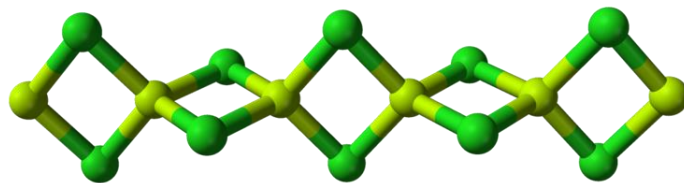
Iznimno otrovan (akutno trovanje, kontaktni dermatitis, berilioza...)



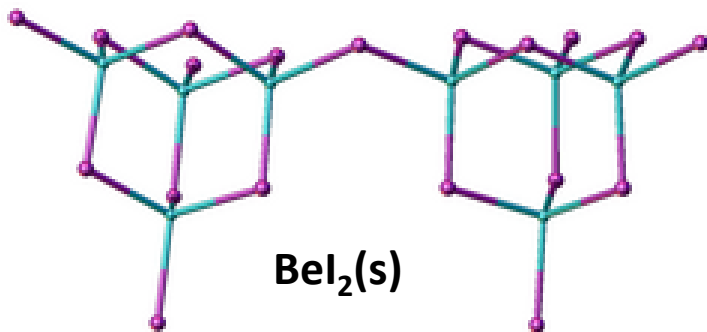
halogenidi



$\text{BeF}_2(\text{s})$

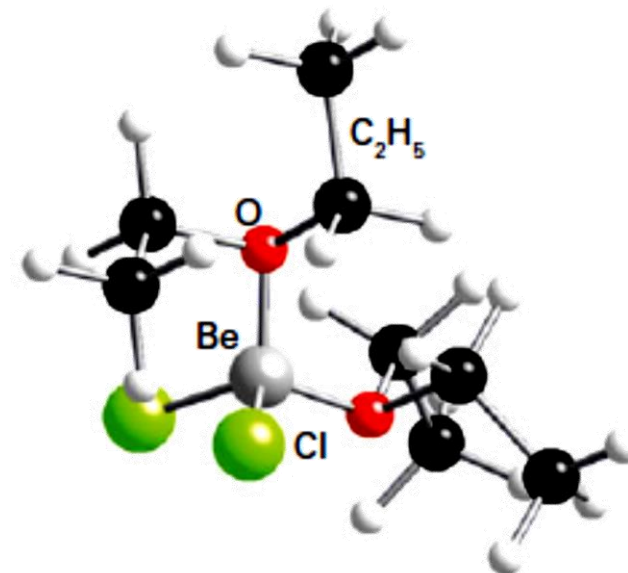
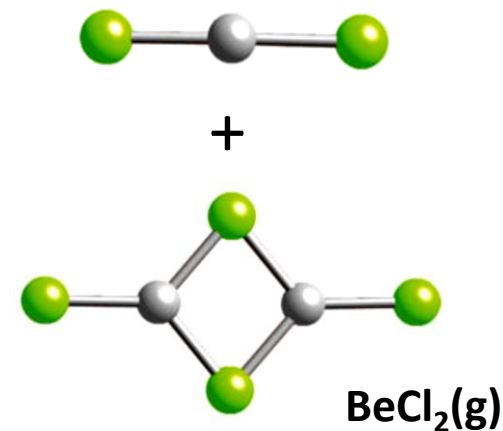
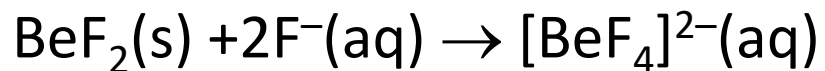


$\text{BeCl}_2(\text{s})$ (isto Br)



$\text{BeI}_2(\text{s})$

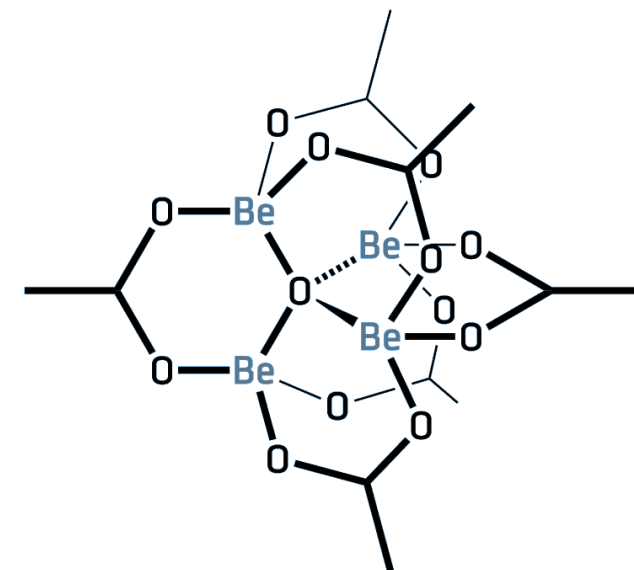
Lewisove kiseline



BERILIJ

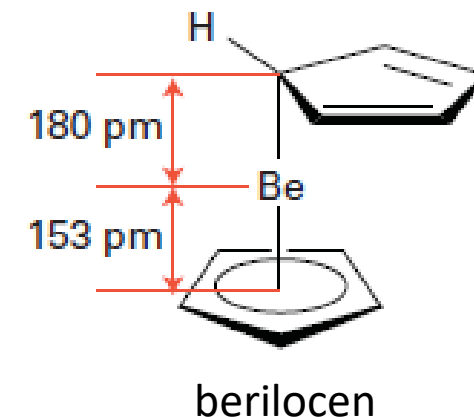
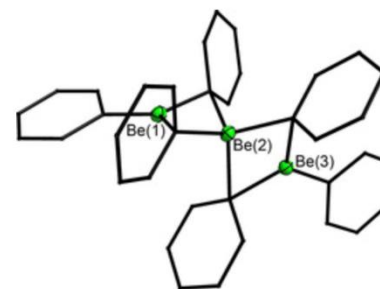
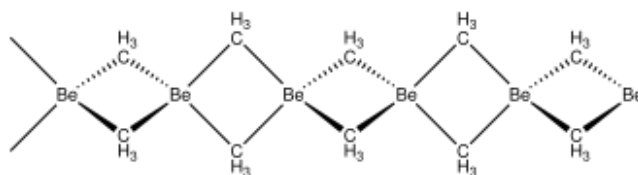
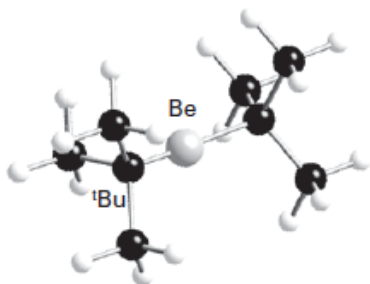
bazični karboksilati berilija – $\text{Be}_4\text{O}(\text{O}_2\text{CR})_6$

$\text{Be}_4\text{O}(\text{O}_2\text{CCH}_3)_6$ – strukture analogne cinkovom bazičnom acetatu, otapanjem oksida, hidroksida ili karbonata u vrućoj octenoj kiselini



organoberilijevi spojevi:

Strukturno raznoliki, ali relativno slabo istraženi



MAGNEZIJ

od *Magnesia*, (pokrajina u Tesaliji). J. Black, 1755. prepoznao novu 'zemlju', H. Davy, 1808. pripremio metal elektrolizom smjese oksida s živinim oksidom i uparavanjem žive iz nastalog amalgama

karnalit $\rightarrow \text{KCl} \cdot \text{MgCl}_2 \cdot 6\text{H}_2\text{O}$

epsomit $\rightarrow \text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ (gorka, epsomska sol, rabi se u medicini, proizvodnji sapuna)

dolomit $\rightarrow \text{MgCO}_3 \cdot \text{CaCO}_3$

biogeni element – u sastavu preko 300 enzima (veže molekulu ATP-a), klorofila, ...

Proizvodnja oko 1,1 Mt godišnje

većinom žarenjem dolomita i redukcijom oksida (fero)silicijem

$2\text{MgO} \cdot \text{CaO} + \text{Si} \rightarrow 2 \text{Mg} + \text{Ca}_2\text{SiO}_4$

Poraba primarno u legurama

Organomagnezijevi spojevi u organskoj sintezi (Grignard)



Kalcij

od lat. *calx* = vapno

1808. Sir H. Davy elektrolizom smjese oksida s živinim oksidom i uparavanjem žive iz nastalog amalgama

5. najzastupljeniji element u Zemljinoj kori; proizvodnja ruda, oko 5 Gt godišnje

Elementarni (elektroliza klorida ili redukcija oksida aluminijem) u metalurgiji (proizvodnja čelika)

Spojevi u građevini, dodatci prehrani, ...

CaCO_3 – kalcit, aragonit i vaterit; uklanjanje ugljikova dioksida iz atmosfere otapanjem kalcijevih silikatâ

CaSO_4 – anhidrit (bezvodni); dihidrat gips

CaO – živo vapno

Ca(OH)_2 – gašeno vapno

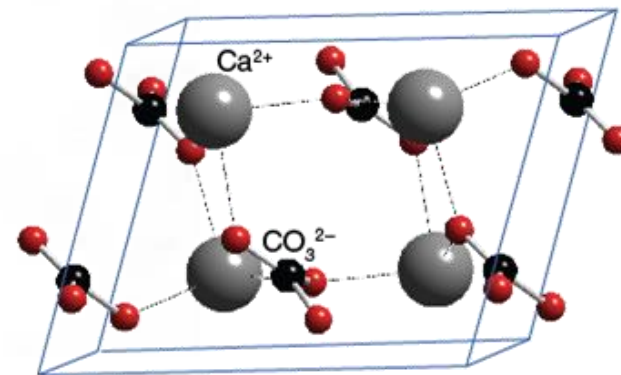
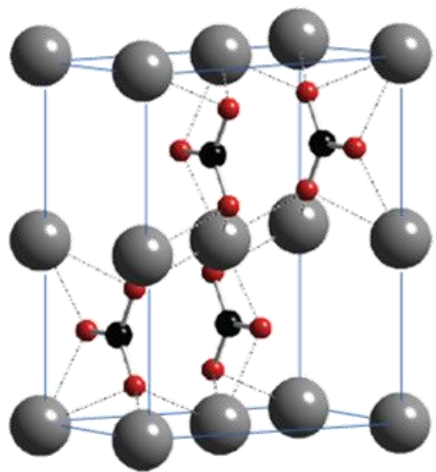
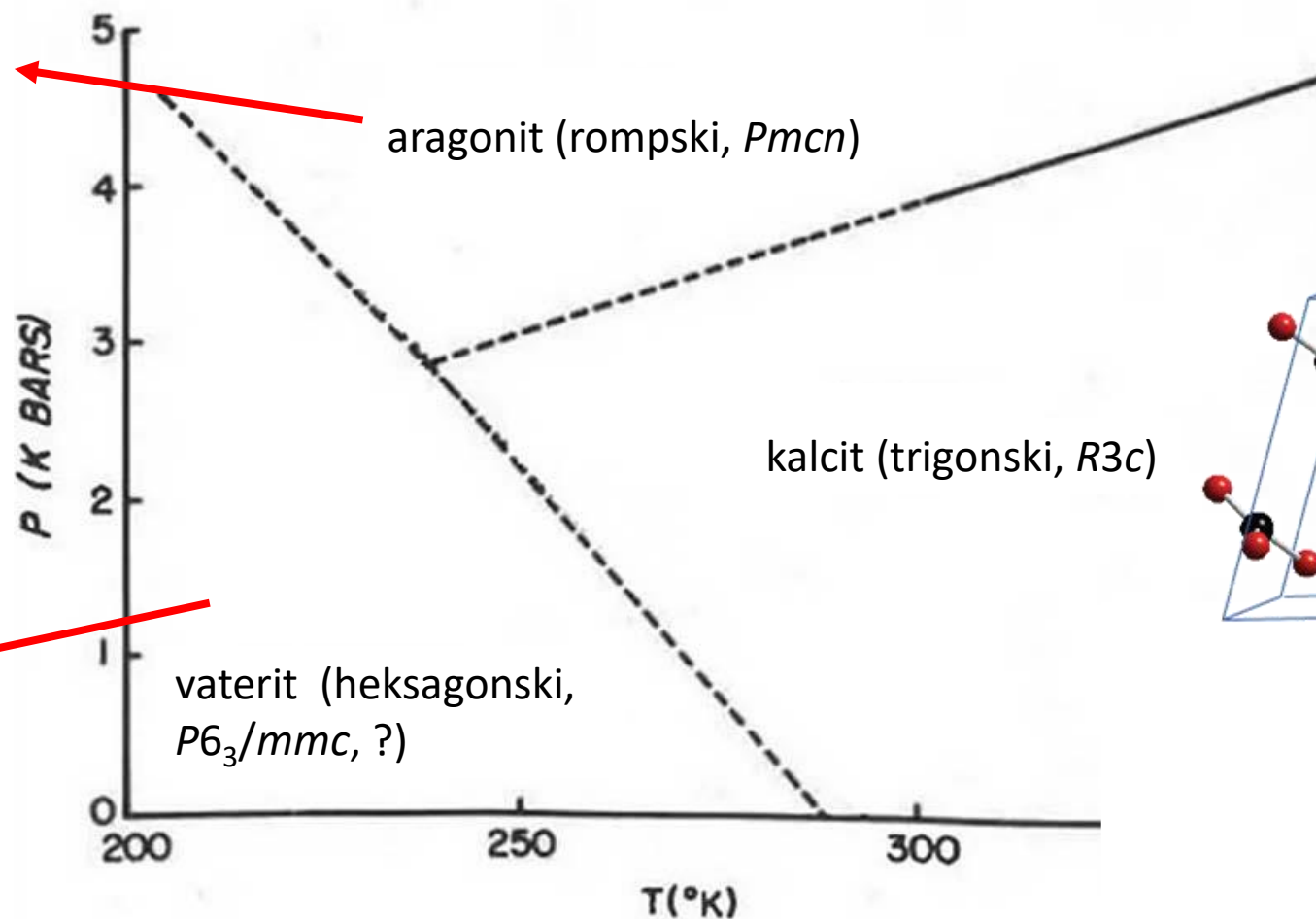
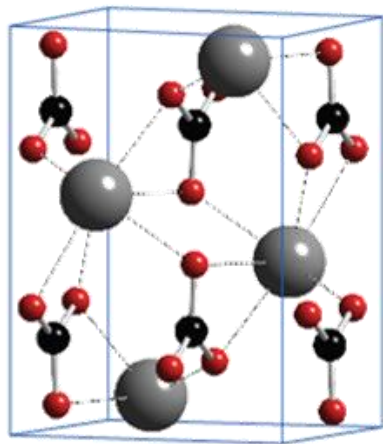


Kipovi iz Ain Ghazala od vapnene žbuke
(oko 7200 – 6200 pne)



Dvolom laserskog snopa na kristalu kalcita

KALCIJEVI KARBONATI



STRONCIJ, BARIJ, RADIJ

Stroncij

Od *Strontian* (*Sròn an t-Sìthein*) = selo u Škotskoj

A. Crawford, 1790. (novi mineral nađen blizu Strontiana – stroncijanit = SrCO_3);

Sir H. Davy 1808. elementarni

SrSO_4 – celestin (zbog blago plave boje)

Oko 400 kt godišnje, većinom za staklo za televizore u boji (nekoć), pirotehnika, fosforescentni premazi, paste za zube...

Barij

Od gr. *βαρύς* = težak

C. W. Scheele, 1774. BaO ; Sir H. Davy 1808. elementarni

BaSO_4 – barit (zbog težine); umjetni sitno dispergirani kao kontrastno sredstvo za rentgenografiju probavila

Oko 2 Mt godišnje, uklanjanje plinova iz vakuumskih cijevi (nizak tlak para), pirotehnika, bojila...

Otrovan ($\text{LD}_{50} \approx 10 \text{ mg/kg}$)

Radij

Od lat. *radius* = zraka ($t_{1/2} (^{226}\text{Ra}) \approx 1600 \text{ god}$)

P. i M. Curie, 1898 g, iz uranovog smolinca

Nekoć za premaze koji svijetle (kazaljke i brojčanici satova) i u kozmetici (!!!)



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The latest product of Radium shows a continuous stream of Radium. As Energy goes in, you get out. A large volume flows from the source, from day to day.

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Rays of Radium, in fact, merge and remerge with the skin, which they enter to control. They are "merged" by the human skin, which they enter to control.

They are wonderful lines for betterment but have been excluded in "Radium" Toilet Requisites. They are the power of the skin, the power of the skin, the power of the skin.

Radium Toilet Requisites are delightfully easy and distinctive. They have an exquisite

and exclusive fragrance all their own, a perfume not to be said in any market. They are the first and only preparations for the toilet to contain Actual Radium—Nature's greatest aid to Beauty.

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Each and every "Radium" Beauty Aid is the result of a human Radium operation. Radium, which flows from Radium, can well choose "Radium" Preparation for human betterment for the daily sustenance of the human skin, the human skin, the human skin.

When the greatest of toilet preparations, is added the power of Actual Radium, the power of Actual Radium, the power of Actual Radium.

From history "Radium" Beauty Aid is the result of a human Radium operation. Radium, which flows from Radium, can well choose "Radium" Preparation for human betterment for the daily sustenance of the human skin, the human skin, the human skin.

"Radium" Face Powder is wonderful! "Radium" Face Powder is wonderful! "Radium" Face Powder is wonderful! "Radium" Face Powder is wonderful!

"Radium" Toilet Requisites are the result of a human Radium operation. Radium, which flows from Radium, can well choose "Radium" Preparation for human betterment for the daily sustenance of the human skin, the human skin, the human skin.

They are wonderful lines for betterment but have been excluded in "Radium" Toilet Requisites. They are the power of the skin, the power of the skin, the power of the skin.

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Rador

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"Rador" Toilet Requisites are necessarily lighter in price. This must be expected in preparations containing the finest ingredients only, plus a definite quantity of Actual Radium. But the greater benefits obtained from "Rador" Preparations would justify an even higher price. The best is always the cheapest and goes further.

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Nixie for your complexion improves with "Rador" Pens de Velour (night cream).

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Enjoy the dressing, dress Radium. They are the power of the skin, the power of the skin, the power of the skin.

They are wonderful lines for betterment but have been excluded in "Radium" Toilet Requisites. They are the power of the skin, the power of the skin, the power of the skin.

Radium Toilet Requisites are delightfully easy and distinctive. They have an exquisite

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