

# 8. ZEMNOALKALIJSKI METALI

1																				18	
2																					
3																					
4																					
5																					
6		*																			
7		**																			
		*																			
		**																			

Group 2 elements highlighted in orange:

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

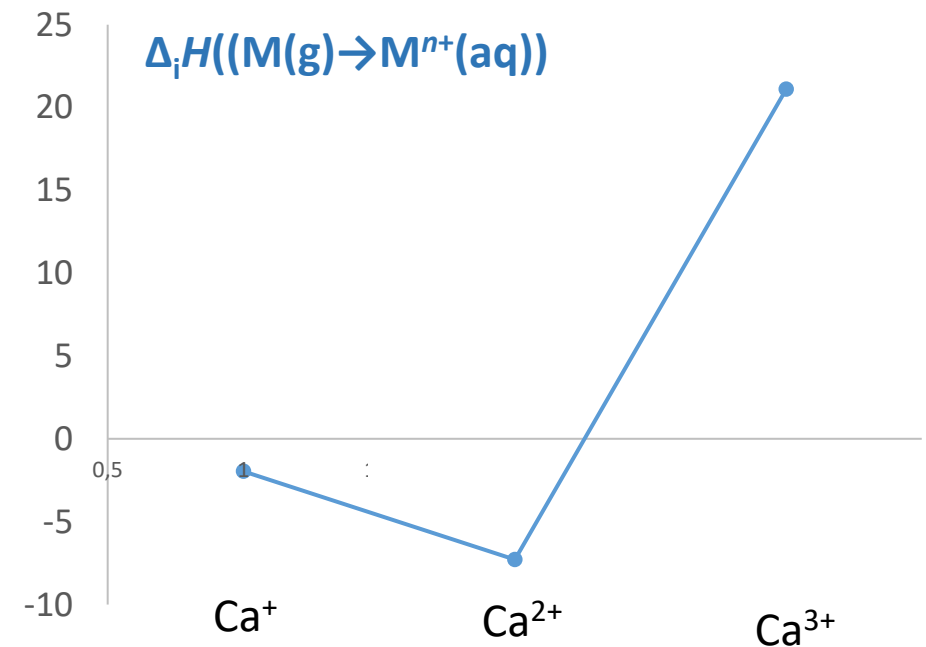
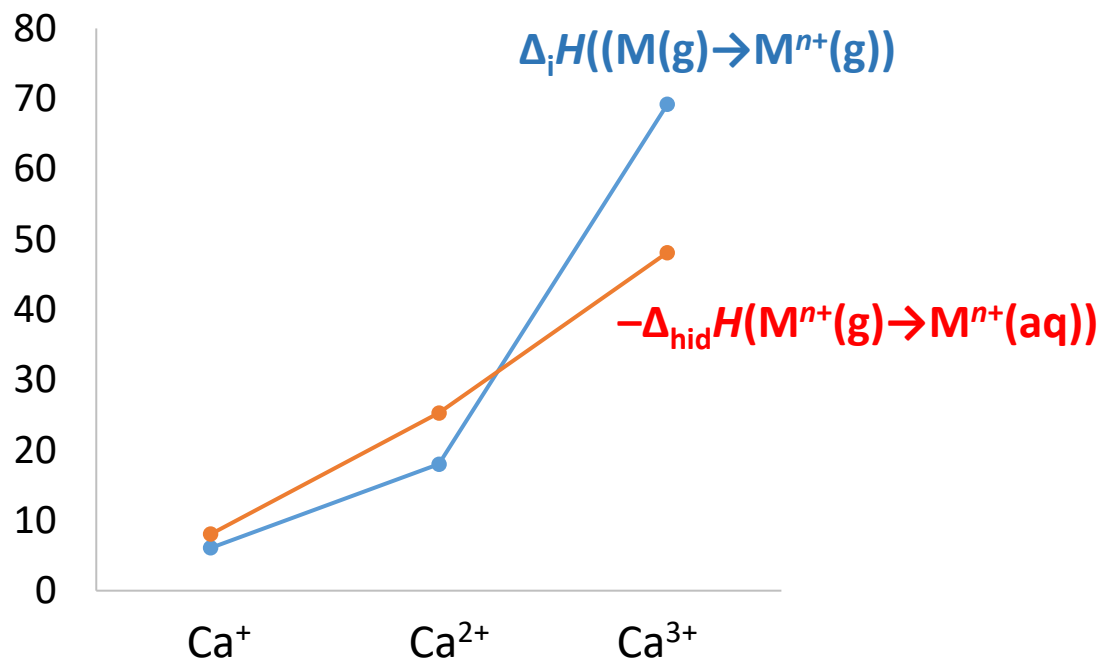
© 2015 Todd Helmenstine  
sciencememes.org

	Be	Mg	Ca	Sr	Ba	Rn.
Zastup. %	$6 \cdot 10^{-4}$	2,09	3,63	0,015	0,040	$10^{-10}$
Gustoća $\text{gcm}^{-3}$	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 $\text{gcm}^{-3}$	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 ( $\text{kJmol}^{-1}$ )	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)

$\Delta H(M(g) \rightarrow M^{2+}(g)) \gg \Delta H(M(g) \rightarrow M^+(g))$ , ali u **svim** reakcijama nastaju isključivo kationi  $M^{2+}$

- Kationi (i anioni) većeg naboja rade jače veze s okolnim atomima  $\rightarrow$  veće (tj. negativnije) energije kristalnih rešetki, hidratacije...



## 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 – 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 :

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

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

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

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

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

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

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

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

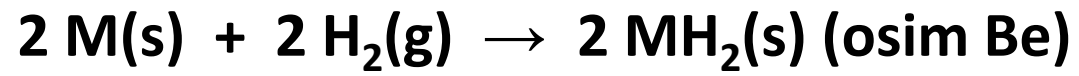
$$K_{sp}(SrSO_4) = 7,6 \cdot 10^{-7} \text{ mol}^2 \text{ dm}^{-6}$$

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

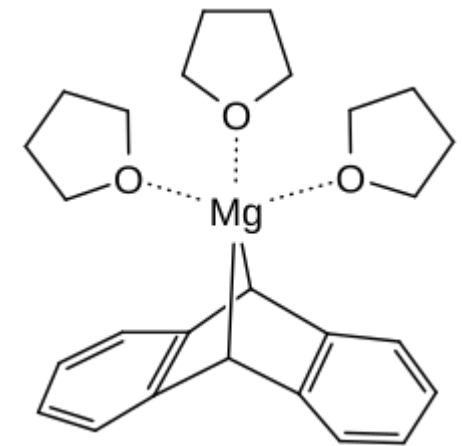
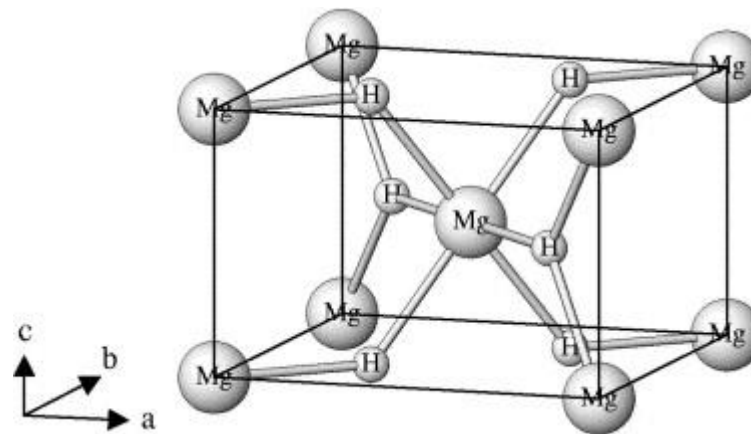
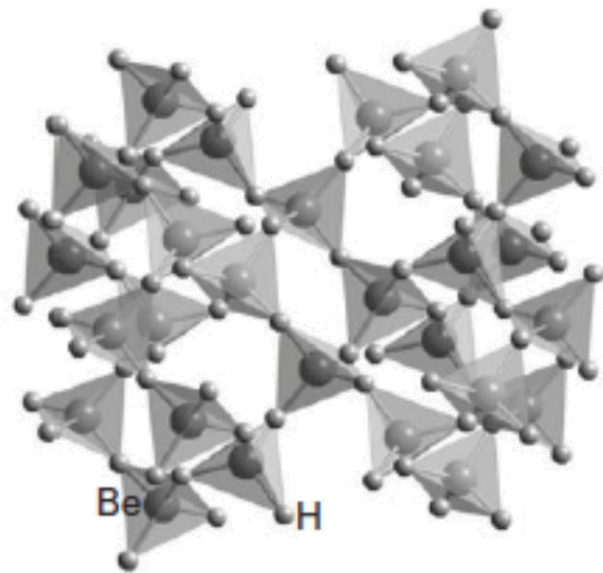
$$K_{sp}(RaSO_4) = 4,0 \cdot 10^{-11} \text{ mol}^2 \text{ dm}^{-6}$$

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

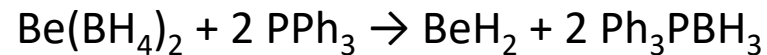
Soli često kristaliziraju kao hidrati.



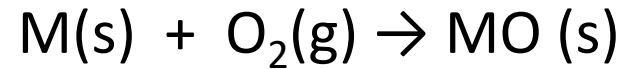
(MgH<sub>2</sub> lakše nastaje hidrogeniranjem „Mg-antracena“)



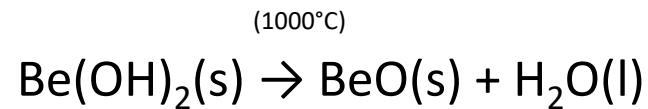
Mg-antracen



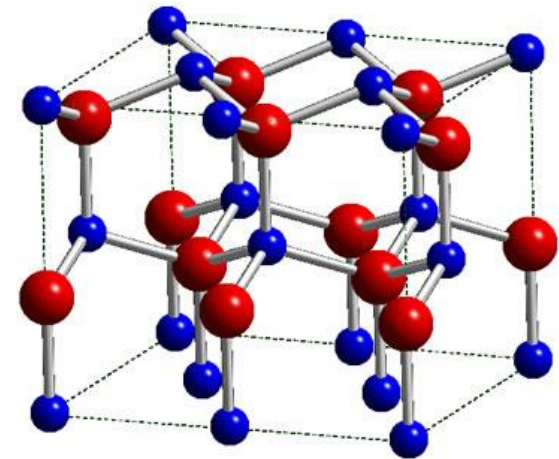
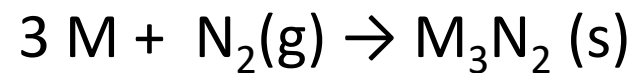
## Reakcije s O<sub>2</sub>

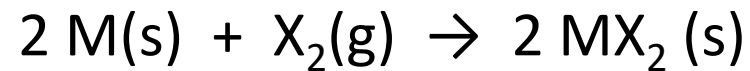


Oksidi – bazični (BeO amfoteran); stabilni na povišenim temperaturama; mogu se dobiti i termičkim raspadom karbonatâ; slaba topljivost u vodi; visoka tališta, kristaliziraju po tipu NaCl

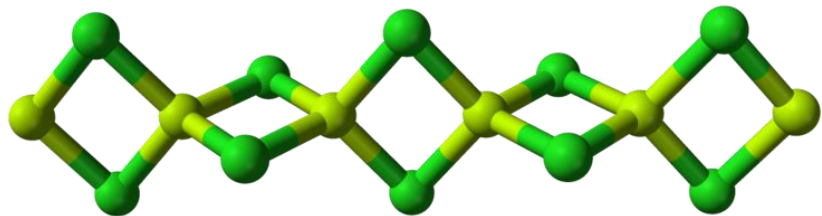


## Reakcije s N<sub>2</sub> (ili NH<sub>3</sub>)



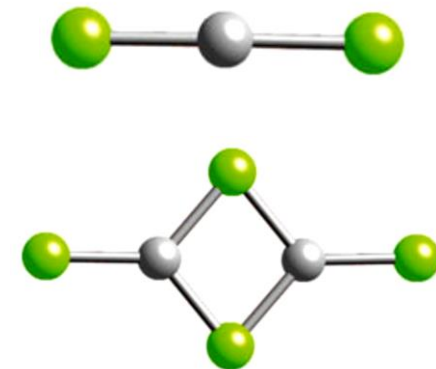
Reakcije s halogenim elementima

Halogenidi – ionski spojevi osim berilijevog klorida, bromida i jodida

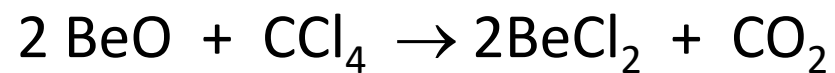


BeCl<sub>2</sub>(s) (isto Br i I)

iznad 1070 °C



BeCl<sub>2</sub>(g)



# BERILIJ

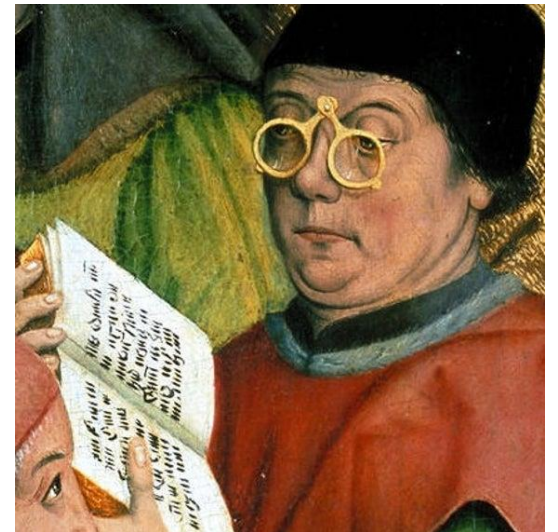
Od *βήρυλλος* = beril (mineral/drugi kamen,  $\text{Be}_3\text{Al}_2\text{Si}_6\text{O}_{18}$ ; usp. njem *Brille*, vjerojatno od भिलर् (*vilar*) = probljediti)

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

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

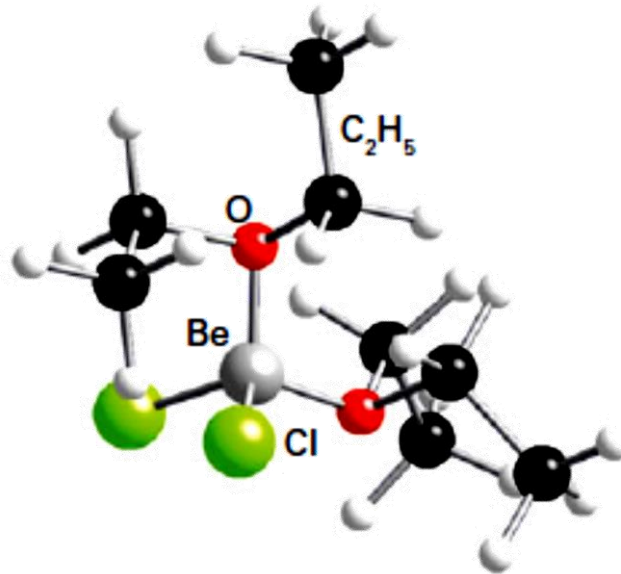
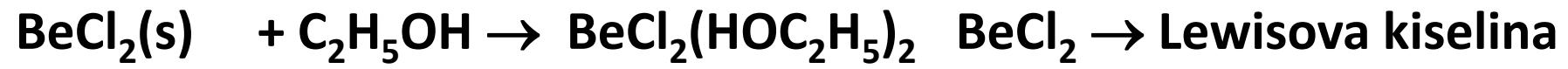
Prozori u izvorima zračenja (npr rentgenske cijevi) i legure Elektronika, nuklearni reaktori...

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



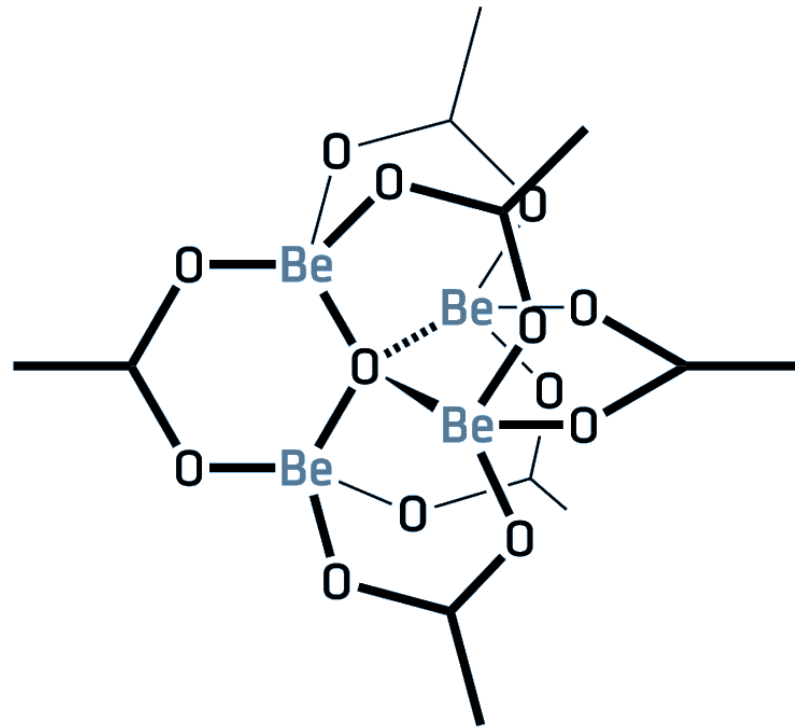


# BERILIJ



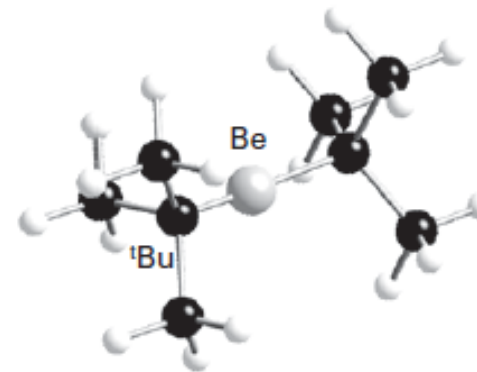
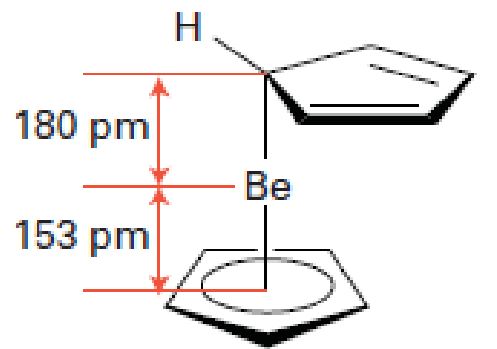
# BERILIJ

“bazični karboksilati berilija” –  $\text{Be}_4\text{O}(\text{OCOCH}_3)_6$



# BERILIJ

Organoberilijevi spojevi:



# MAGNEZIJ

od *Magnesia*, (pokrajina u Tesaliji).

J. Black, 1755. prepoznao novu 'zemlju'

H. Davy, 1808. pripravio metal

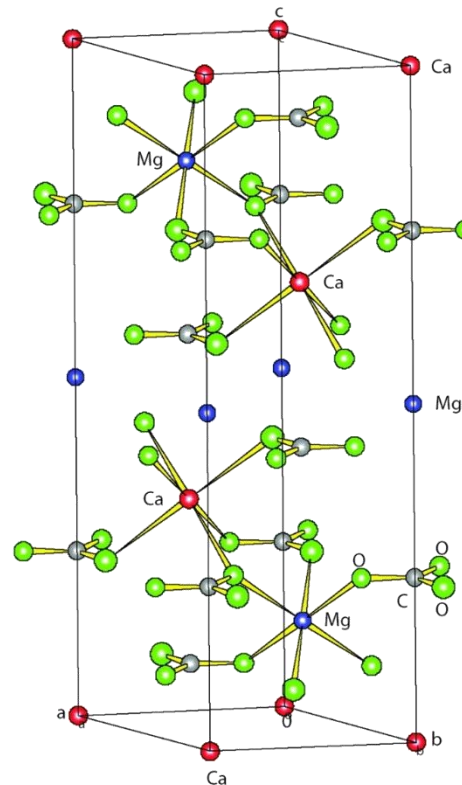
karnalit  $\rightarrow \text{KCl} \cdot \text{MgCl}_2 \cdot 6\text{H}_2\text{O}$

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

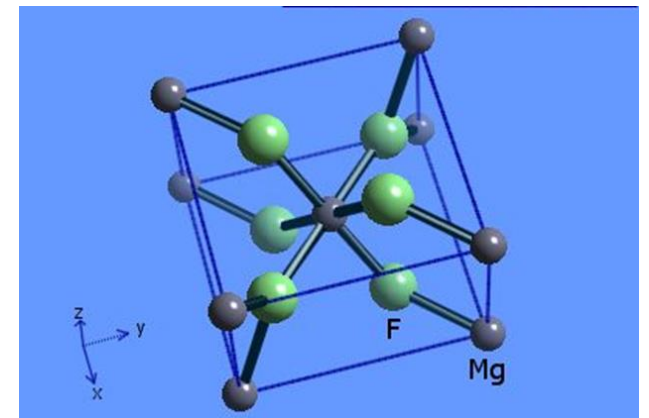
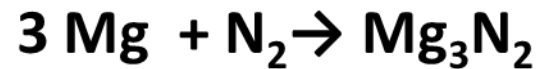
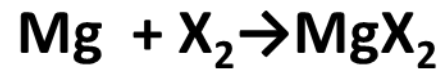
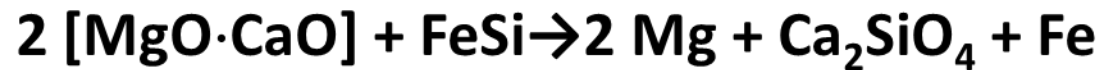
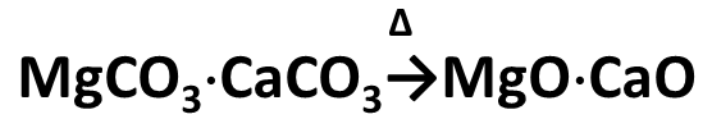
dolomit  $\rightarrow \text{MgCO}_3 \cdot \text{CaCO}_3$

Proizvodnja oko 1.1 Mt godišnje

Poraba primarno u legurama



# MAGNEZIJ



# KALCIJ, STRONCIJ, BARIJ, RADIJ

## Kalcij

Od lat. *calx* = vapno)

1808. → Sir H. Davy

$\text{CaCO}_3$  – kalcit, aragonit i vaterit

$\text{CaSO}_4$  – anhidrit (bezvodni); dihidrat gips

## Stroncij

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

A. Crawford, 1790. (novi mineral nađen blizu Strontiana – stroncijanit =  $\text{SrCO}_3$ )

H. Davy 1808. elementarni

$\text{SrSO}_4$  – Celestin (zbog blago plave boje)

## Barij

Od gr. *βαρύς* = težak

Otkriven: 1774 g. → K. W. Scheele  $\text{BaO}$

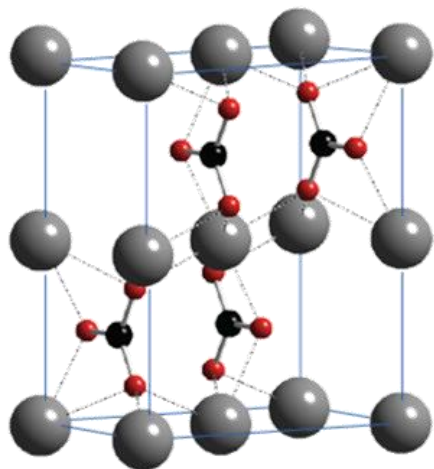
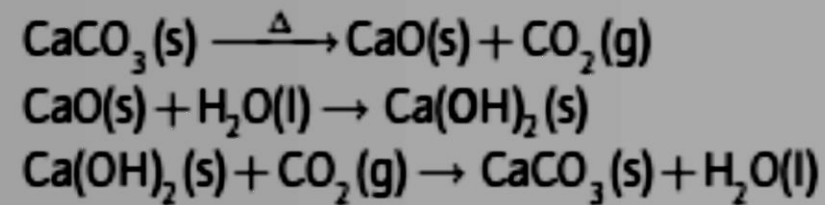
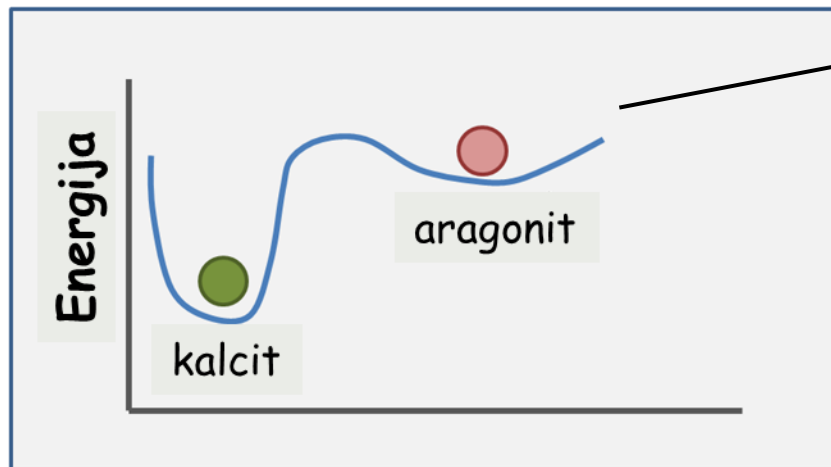
1808 g. → Sir H. Davy

## Radij

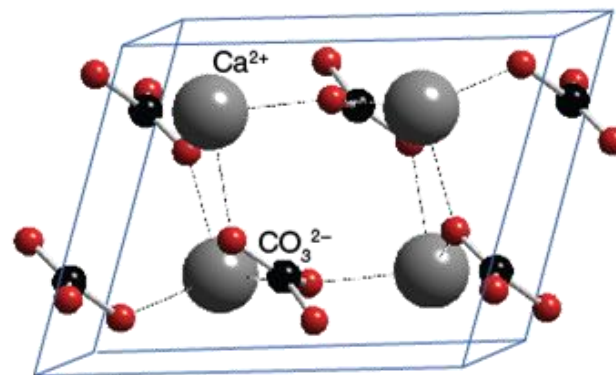
Od lat. *radius* = zraka)

Otkriven: 1898 g. → P. i M. Curie

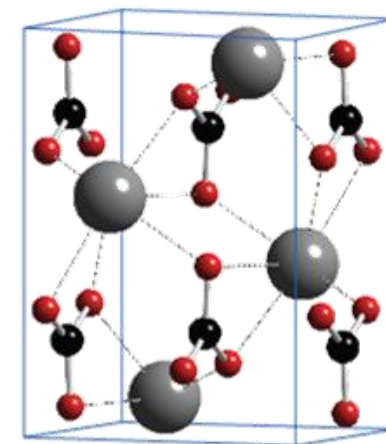
# KALCIJ, STRONCIJ, BARIJ, RADIJ



vaterit (heksagonski)



kalcit (heksagonski)



aragonit (rompski)

# KALCIJ, STRONCIJ, BARIJ, RADIJ





# KALCIJ, STRONCIJ, BARIJ, RADIJ

