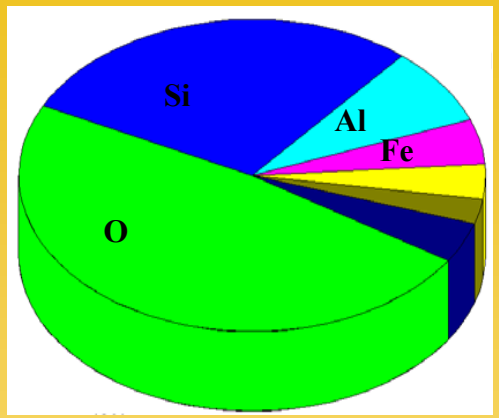
NON LINEAR DOUBLE DAY, SEVILLA 2004

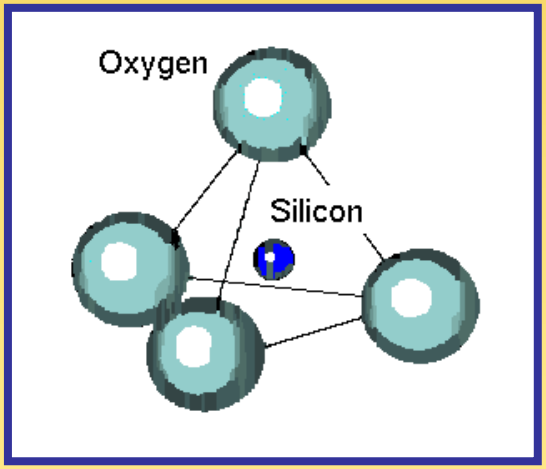
Low Temperature Reconstructive Transformations in Layered Aluminosilicates

Low Temperature Reconstructive Transformations in Layered Aluminosilicates

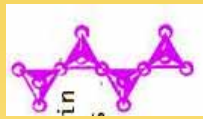
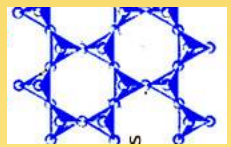
MD Alba, JM Trillo and M Naranjo

SILICATE MINERALS





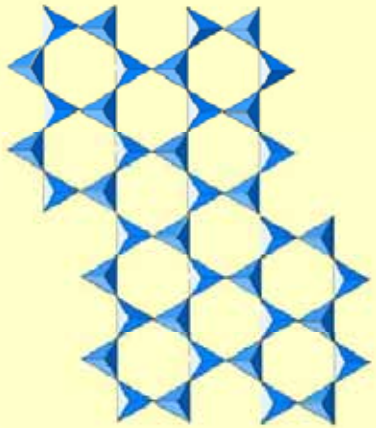
Libeau classification

Q^n	Anion group	Silicate Family	Example	Structure
Q^0	$(SiO_4)^{4-}$	nesosilicate	Forsterite (Mg_2SiO_4) **TEOS:** $(CH_3CH_2)_4SiO_4$	
Q^1	$(Si_2O_7)^{6-}$	Soro- or disilicate	**$Lu_2Si_2O_7$**	
Q^2	$(Si_nO_{2n+n})^{2n-}$	cyclosilicate	Beryl: $Al_2Be_3Si_6O_{18}$	
	$(SiO_3)^{2-}$	inosilicate	Enstatite: $Mg_2Si_2O_6$	
Q^3	$(Si_4O_{10})^{4-}$	phyllosilicate	**Saponite:** $Na_x[Si_{8-x}Al_x][Mg_6]O_{20}(OH)_4$ **Muscovite:** $K_2[Si_4Al_2][Al_4]O_{20}(OH)_4$	
Q^4	SiO_2	tectosilicate	**Silica gel: SiO_2**	

SILICATE MINERALS:
Phyllosilicates

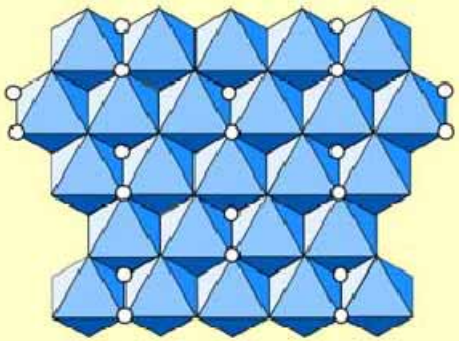
BUILDING BLOCKS

Tetrahedral Layer $(Si_{6+x}Al_{2-x}O_{20})^{10-}$

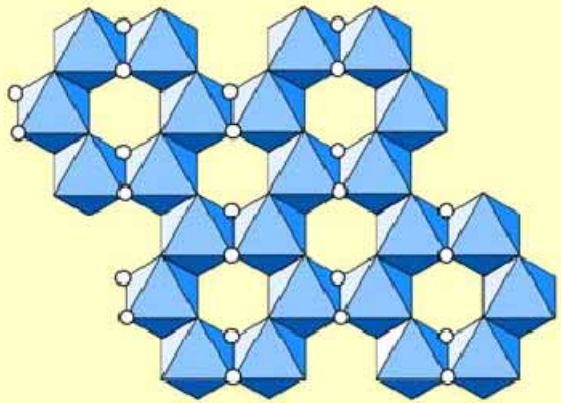


Octahedral Layer

Trioctahedral Layer (Mg^{2+})



Dioctahedral Layer (Al^{3+})

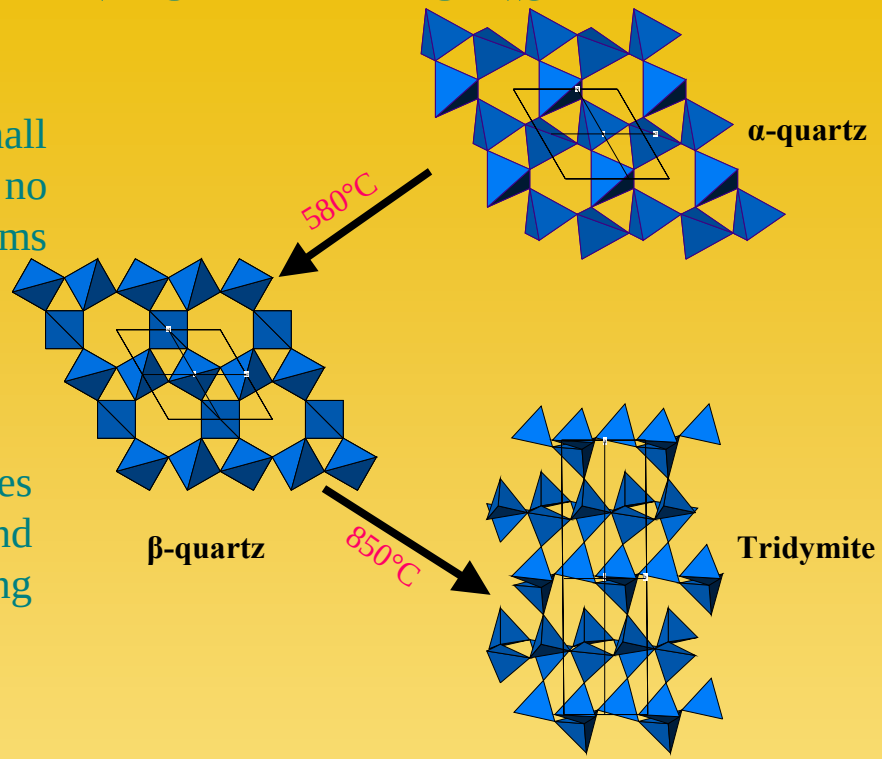


SILICATE MINERALS:
Phyllosilicates

Layer Type	Layer Charge (X)	Group	Species	
			Dioctahedral member	Trioctahedral member
1:1	x=0	Kaolinite-serpentine	Kaolinite Halloysite	Chrisotile
2:1	x=0	Pyrophyllite-Talc	Pyrophyllite	Talc
	0.2?x ?0.6	Smectite	Montmorillonite Beidellite nontronite	Saponite Hectorite
	0.6 ?x ?0.9	Vermiculite	Dioctahedral vermiculite	Trioctahedral vermiculite
	x=1	Mica	Muscovite Paragonite	Phlogopite Biotite
	x=2	Brittle mica	Margarite	Clintonite Mica-4

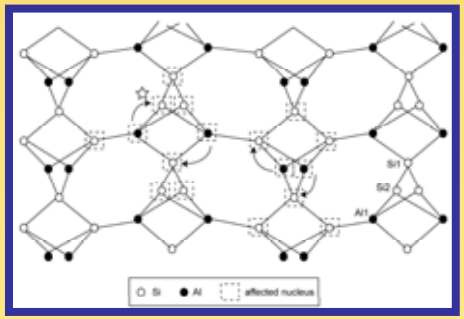
SOLID-SOLID TRANFORMATIONS

*** Displacive Transformation:** It involves only small adjustements to the crystal structure. Generally, no bonds are broken, but the angles between the atoms may change slightly.



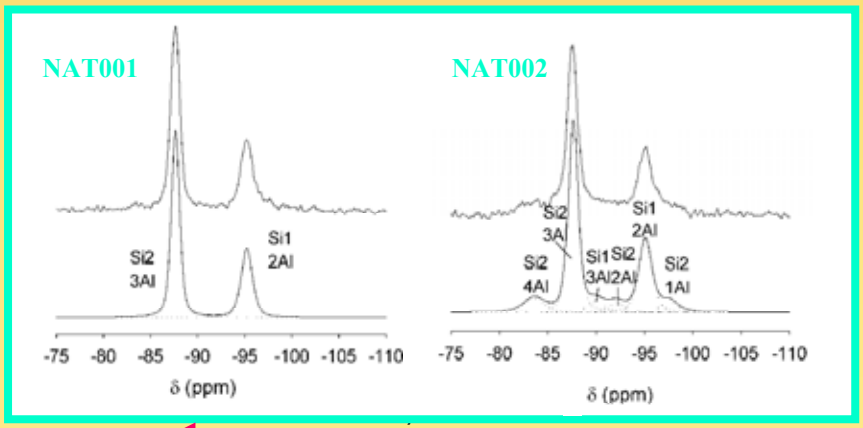
*** Reconstructive Transformation:** It involves extensive rearrangement of the crystal structure and requires breaking of chemical bonds and reassembling the atoms into a different crystal structure.

*** Order-Disorder Transformation:** It involves the state of order or disorder in a crystal structure.



Natrolite:
$[Na_2Al_2Si_3O_{10}.2H_2O]$

^{29}Si MAS NMR

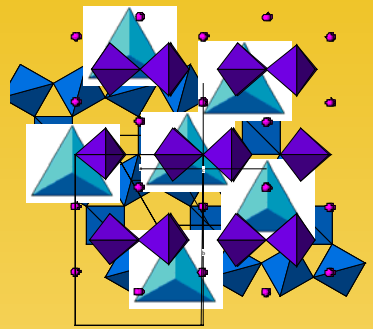


Sample	Site	δ (ppm)	I
NAT001†	Si2(3Al)	−87.6	0.668
	Si1(2Al)	−95.2	0.332
NAT002†	Si2(4Al)	−83.6	.082
	Si2(3Al)	−87.6	.512
	Si1(3Al)	−90.0	.051
	Si2(2Al)	−92.1	.044
	Si1(2Al)	−95.1	.260
	Si2(1Al)	−97.6	.052

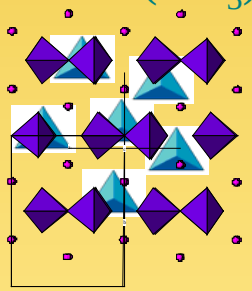
order

RECONSTRUCTIVE TRANFORMATION: Synthesis of $Lu_2Si_2O_7$

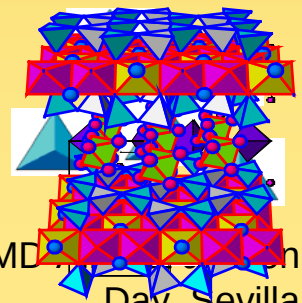
*** Ceramic Method:** $2SiO_2 + Lu_2O_3 \xrightarrow{1500°C} Lu_2Si_2O_7$ (Q^4 → Q^1)



*** Sol-Gel Method:** $TEOS/EtOH + Lu(NO_3)_3/AcOH \xrightarrow{1000°C} Lu_2Si_2O_7$ (Q^0 → Q^1)



*** Hydrothermal Method:** $Saponite + Lu(NO_3)_3 \xrightarrow[H_2O]{300°C} Lu_2Si_2O_7$ (Q^3 → Q^1)



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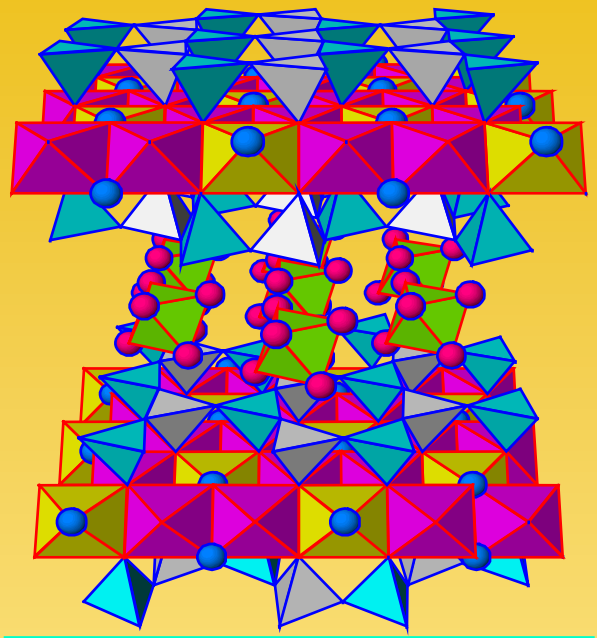
RECONSTRUCTIVE TRANFORMATION:
Smectite

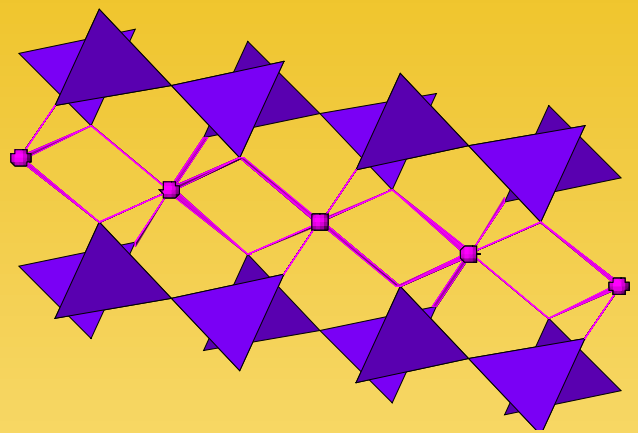
Saponite

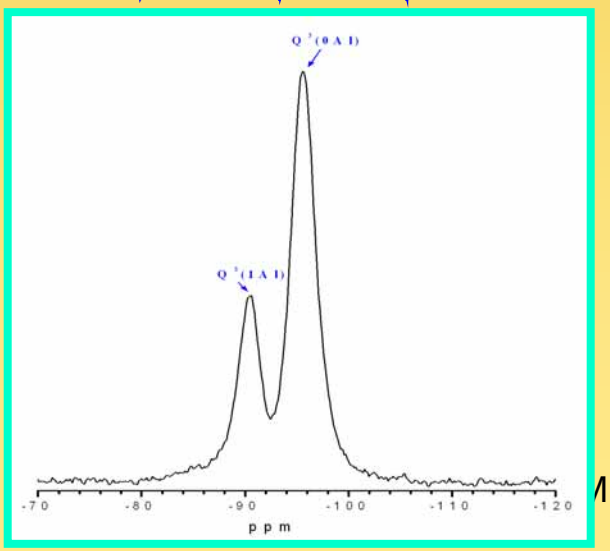


Lu^{3+}

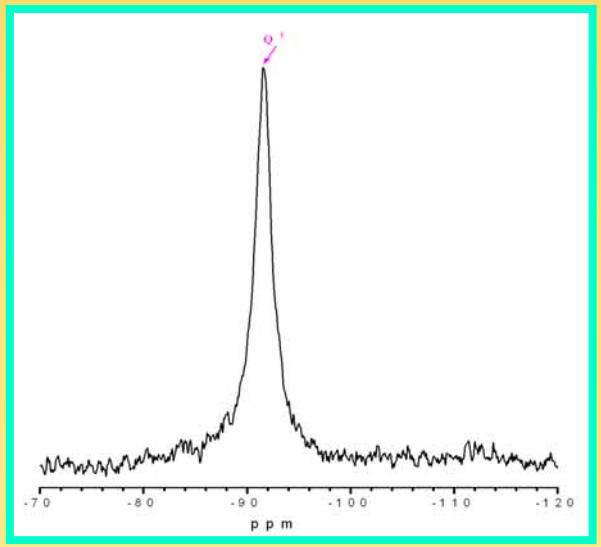
300° C, 2 days

$Lu_2Si_2O_7$





^{29}Si MAS NMR



MD Alba et al, Nonlinear Double Day, Sevilla 2004.

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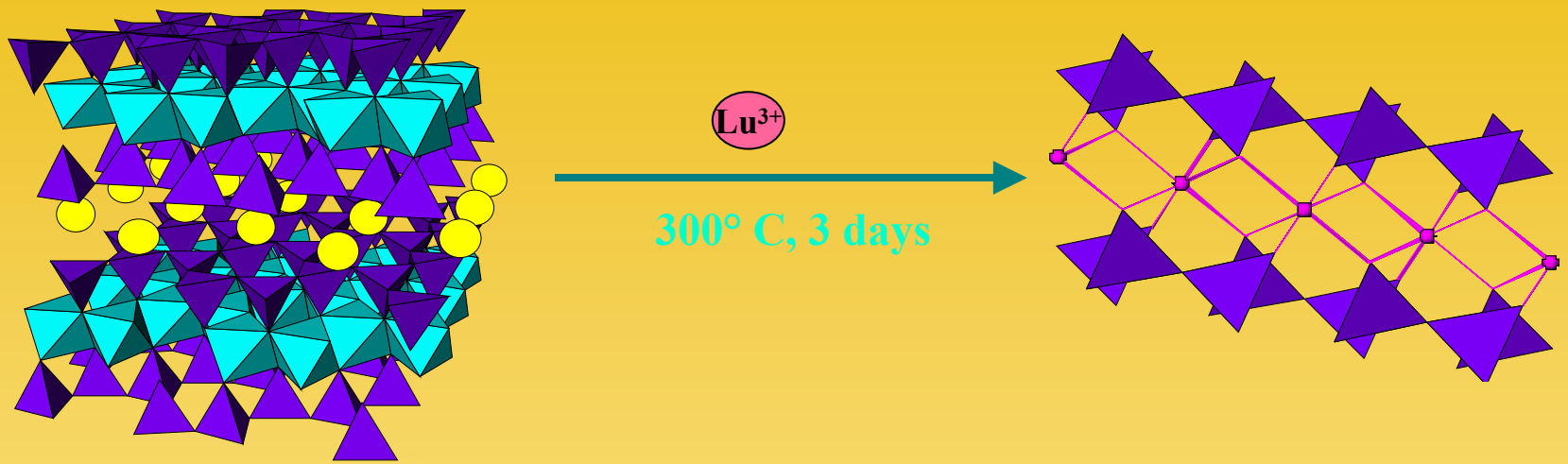
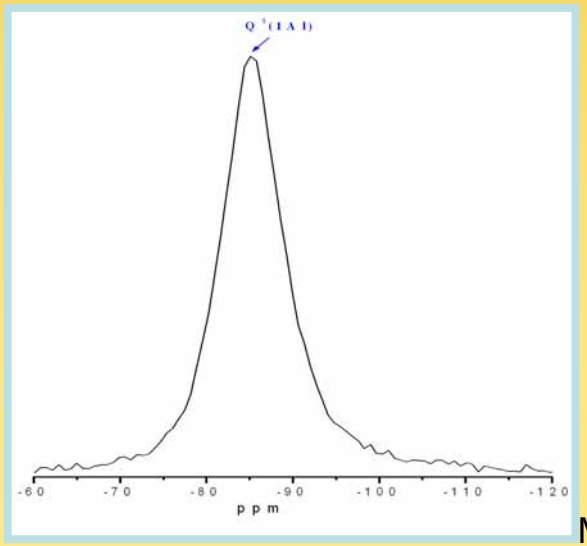
RECONSTRUCTIVE TRANFORMATION:
Muscovite





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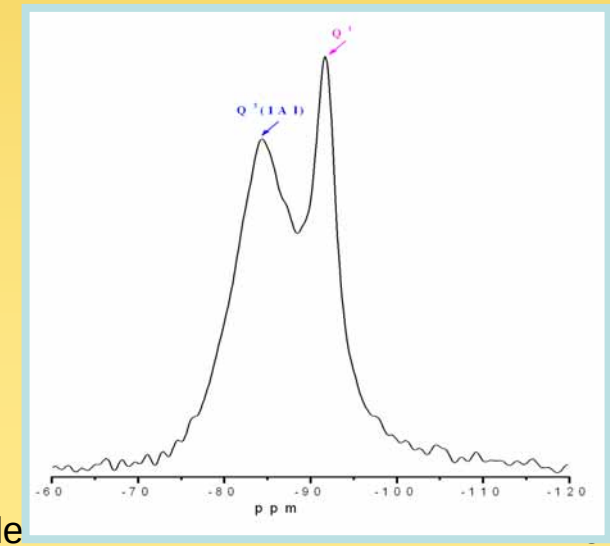

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