



UNIVERSITY OF SOUTH ALABAMA

# GY 302: Crystallography & Mineralogy

Lecture 29: Class VIII-Silicates  
Tektosilicates 3: Feldspathoids & Zeolites

## Last Time

Class VIII Minerals (Tektosilicates)

1. Feldspar Group

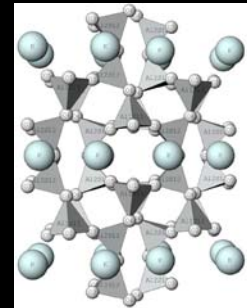
## Tektosilicate Minerals (Feldspars)

Mineral	Formula	System
Potassium Feldspar Group		
*Sanidine	$KAlSi_3O_8$	Monoclinic
Orthoclase	$KAlSi_3O_8$	Monoclinic
Anorthoclase	$(Na, K)AlSi_3O_8$	Triclinic
Microcline	$KAlSi_3O_8$	Triclinic
v. Amazonite	$KAlSi_3O_8$	Triclinic
Plagioclase Feldspars		
Albite (Ab)	$NaAlSi_3O_8$	Triclinic
Oligoclase	$Ab_{10-30}$	Triclinic
Andesine	$Ab_{30-50}$	Triclinic
Labradorite	$Ab_{50-70}$	Triclinic
*Bytownite	$Ab_{70-90}$	Triclinic
Anorthite (An)	$CaAl_2Si_2O_8$	Triclinic

## The Feldspars

General Formula:  
 $XAlSi_3O_8$  or  $XAl_2Si_2O_8$

X =  $Ca^{2+}$ ,  $Na^+$ ,  $K^+$



Two Varieties:

- 1) Alkali Feldspars (incl Orthoclase Group)
- 2) Plagioclase Feldspars

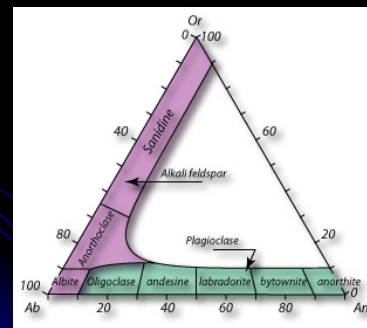
## The Feldspars

Plagioclase Feldspars ( $NaAlSi_3O_8$ - $CaAl_2Si_2O_8$ )

- 1) Albite (Ab) =  $NaAlSi_3O_8$  ( $An_{0-10}$ )
- 2) Oligoclase =  $An_{10-30}$
- 3) Andesine =  $An_{30-50}$
- 4) Labradorite =  $An_{50-70}$
- 5) Bytownite =  $An_{70-90}$
- 6) Anorthite (An) =  $CaAl_2Si_2O_8$

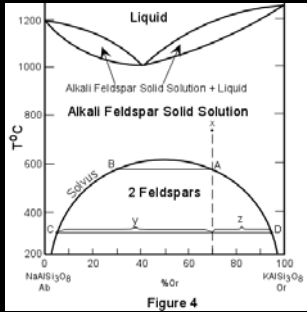
↑ solid solution

## Tektosilicate Minerals (Feldspars)



## Tektosilicate Minerals (Feldspars)

Phase diagrams to the rescue!



## Today's Agenda

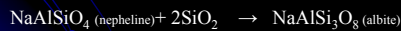
### Class VIII Minerals (Tektosilicates)

1. Feldspathoids
2. Zeolites

## Tektosilicate Minerals (Feldspathoids)

Mineral	Formula	System
Feldspathoids (38)		
Leucite*	KAlSi <sub>3</sub> O <sub>8</sub>	Tetragonal
Nepheline*	NaAlSi <sub>3</sub> O <sub>8</sub>	Hexagonal
Sodalite*	Na <sub>4</sub> (AlSi <sub>3</sub> ) <sub>3</sub> Cl <sub>2</sub>	Isometric
Lazurite	(Na,Ca) <sub>8</sub> (AlSi <sub>5</sub> ) <sub>6</sub> (SO <sub>4</sub> ,S,Cl) <sub>2</sub>	Isometric

- Feldspathoids contain 2/3 the silica that feldspars do (hence the name).
- They form in alkali-rich igneous rocks in place of feldspars when there is an Si<sup>4+</sup> deficiency
- You never find feldspathoids and quartz together in the same rock



## Tektosilicate Minerals (Feldspathoid)

### Leucite [KAlSi<sub>3</sub>O<sub>8</sub>]

Crystal: Tetragonal  
Pt. Group: 4/m  
Habit: euhedral crystals  
SG: 2.47; H: 6  
L: vitreous; Str: white  
Col: colourless, grey, yellow  
Clev: indistinct [110]  
Optics: isotropic; n=1.508-1.511  
Occurrence: felsic igneous rocks



<http://webmineral.com>

From the Greek "leukos" for white

## Tektosilicate Minerals (Feldspathoids)

### Nepheline [(Na,K)AlSi<sub>3</sub>O<sub>8</sub>]

Crystal: Hexagonal  
Pt. Group: 6  
Habit: prismatic, slender prisms  
SG: 2.59; H: 6  
L: vitreous-greasy; Str: white  
Col: white, grey, brown, reddish  
Clev: poor [1010]  
Optics: uniaxial (-); bir=0.003-0.005  
n<sub>e</sub>=1.528; n<sub>w</sub>=1.531  
Occurrence: Si-poor igneous rocks



<http://webmineral.com>

From the Greek *nephela*, "cloud," because it becomes clouded when put in strong acid

## Tektosilicate Minerals (Feldspathoids)

### Sodalite [Na<sub>8</sub>Al<sub>6</sub>Si<sub>6</sub>O<sub>24</sub>Cl<sub>2</sub>]

Crystal: Isometric  
Pt. Group:  $\bar{4}3m$   
Habit: massive, vein-fill  
SG: 2.29; H: 6  
L: vitreous-greasy; Str: white  
Col: azure blue, white, pink, grey  
Clev: poor [110]  
Optics: isotropic; n=1.483-1.484  
Occurrence: Nepheline syenites



<http://www.carolevans.com/USERIMAGES/sodalite-rough.jpg>

Named on the basis of its sodium content

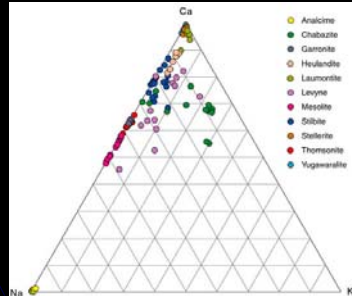


## Tektosilicate Minerals (Zeolites)

There are more than 50 "zeolite" minerals that are now subdivided into "true zeolites" (see diagram to right) and related species.

Many single minerals are further subdivided into cation-rich members, e.g.,

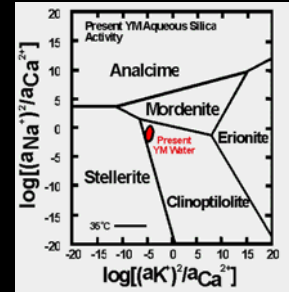
Ca-Heulandite  
Na-Heulandite  
K-Heulandite  
Ba-Heulandite



## Tektosilicate Minerals (Zeolites)

You can also classify zeolites according to chemical criteria like water composition.

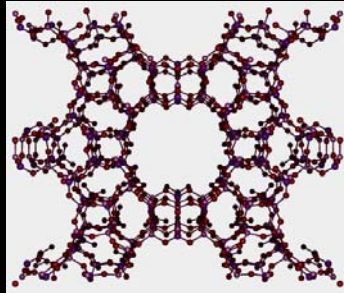
Beware **Eronite**; it's fibrous and is deemed a carcinogen.



<http://www.ees1.lanl.gov/experiment/geochem.htm>

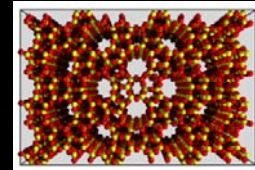
## Tektosilicate Minerals (Zeolites)

Zeolite minerals are cool! They are **nanoporous**, built up from silicon and aluminum tetrahedra to form a regular three-dimensional framework.



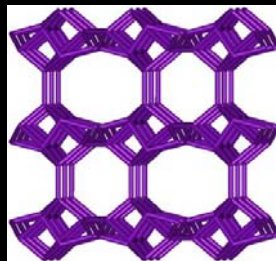
## Tektosilicate Minerals (Zeolites)

Zeolites contain channels or pores of molecular diameter, typically around 0.5 nanometers.



## Tektosilicate Minerals (Zeolites)

Reactant molecules may wander, or diffuse, into these pores and undergo chemical reactions, thus being transformed into desired products.



## Tektosilicate Minerals (Zeolites)

Or if you prefer, zeolites are nanosieves that can remove nasty stuff.

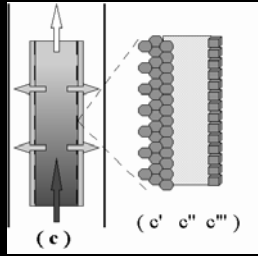
•Odors (cat litter, vomit)



## Tektosilicate Minerals (Zeolites)

Or if you prefer, zeolites are nanosieves that can remove nasty stuff.

- Odors (cat litter, vomit)
- Salts in water ( $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ )

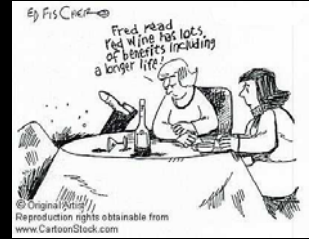


<http://academic.sun.ac.za/insoc/>

## Tektosilicate Minerals (Zeolites)

Or if you prefer, zeolites are nanosieves that can remove nasty stuff.

- Odors (cat litter, vomit)
- Salts in water ( $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ )
- Human Health?

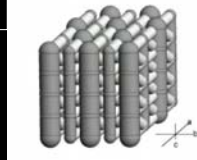


[http://www.cartoonstock.com/news/cartoons/cartoons/edi\\_lowres/edi538.jpg](http://www.cartoonstock.com/news/cartoons/cartoons/edi_lowres/edi538.jpg)

## Tektosilicate Minerals (Zeolites)

### LIQUID ZEOLITE™

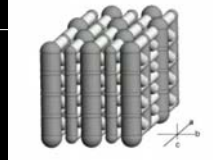
LIQUID ZEOLITE™ is a natural fast-acting super detoxifier. It is safe to use. LIQUID ZEOLITE™ comes from the only ore supply that's been approved as safe for consumption by humans. In addition, it has been processed in such a way that it can NEVER withdraw necessary minerals or elements from your body — only the harmful ones. In fact, it actually helps to remineralize your cells. 100% Pure Clinoptilolite. LIQUID ZEOLITE™ is composed 100% of the zeolite subgroup called "clinoptilolite" — the type of zeolite that has generated such amazing results in laboratory testing.



## Tektosilicate Minerals (Zeolites)

### LIQUID ZEOLITE™

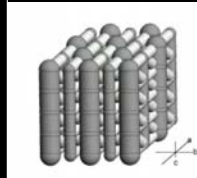
LIQUID ZEOLITE™ is a natural fast-acting super detoxifier. It is safe to use. LIQUID ZEOLITE™ comes from the only ore supply that's been approved as safe for consumption by humans. In addition, it has been processed in such a way that it can NEVER withdraw necessary minerals or elements from your body — only the harmful ones. In fact, it actually helps to remineralize your cells. 100% Pure Clinoptilolite. LIQUID ZEOLITE™ is composed 100% of the zeolite subgroup called "clinoptilolite" — the type of zeolite that has generated such amazing results in laboratory testing.



## Tektosilicate Minerals (Zeolites)

### LIQUID ZEOLITE™

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## Tektosilicate Minerals (Zeolites)

### LIQUID ZEOLITE™

LIQUID ZEOLITE™ is a natural fast-acting super detoxifier. It is safe to use. LIQUID ZEOLITE™ comes from the only ore supply that's been approved as safe for consumption by humans. In addition, it has been processed in such a way that it can NEVER withdraw necessary minerals or elements from your body — only the harmful ones. In fact, it actually helps to remineralize your cells. 100% Pure Clinoptilolite. LIQUID ZEOLITE™ is composed 100% of the zeolite subgroup called "clinoptilolite" — the type of zeolite that has generated such amazing results in laboratory testing. It is chemical free. LIQUID ZEOLITE™ is processed without chemicals. Through a natural, proprietary process, concentrated organic humic acid molecules have "naturally digested" the zeolite, holding it in permanent suspension. LIQUID ZEOLITE™ is chemical-free, no chemicals, solvents or heat-treating methods are used in our proprietary natural holistic manufacturing process. It has maximum bioavailability. Because the humic acid in LIQUID ZEOLITE™ is in organic, interdimensional form, and because the zeolite is actually suspended in the humic molecules, 100% of LIQUID ZEOLITE™ is carried into the cells. It has anti-aging properties. Because LIQUID ZEOLITE™ uses interdimensional humic acid to carry the zeolite to your cells, the anti-aging properties of organic humic acid "come with." There is no substitute for organic humic acid to revitalize our cells and reverse cellular degeneration. What makes natural intracellular LIQUID ZEOLITE™ in humic acid better than other major brands of liquid zeolite? Many other brands use chemicals and solvents or heat treatment methods to process their zeolite into a liquid form. Natural intracellular LIQUID ZEOLITE™ utilizes the newest most advanced manufacturing process of using humic acid (a highly regarded organic medium) which enables the zeolite to penetrate cell walls.

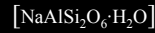
The human body views the clinoptilolite zeolite as a natural mineral, which is not absorbed by the body. Zeolite will pass through the body, absorbing toxins and heavy metals like a magnet with its cage-like structure and negative charge, and then will be excreted by the body naturally within 5 to 7 hours. Such a mechanism enables long-term use without side effects and toxicity.

## Tektosilicate Minerals (Zeolites)

DISCLAIMER: The statements enclosed herein have not been evaluated by the Food and Drug Administration. The products and information mentioned on the websites or printed literature of LiquidZeolite Bz are not intended to diagnose, treat, cure, mitigate or prevent any disease. Information and statements made are for education purposes and are not intended to replace the advice of your treating doctor. LiquidZeolite Bz does not dispense medical advice, prescribe, or diagnose illness. Benefits of non-Rx, dietary supplements VARY from person to person. If you are pregnant, nursing, taking medication, or have a medical condition, consult with your doctor before using any supplements. If you have a bad reaction to taking any supplements, discontinue use. Keep all non-Rx dietary supplements out of reach of children. Store all products in a cool, dry place with lids tightly closed. Do not use if seals are broken. The views and nutritional advice expressed by LiquidZeolite Bz are not intended to be a substitute for conventional medical service. If you have a medical condition, see your physician of choice. **PRIVACY NOTICE:** Your information is NEVER shared nor sold to ANYONE else. We will NOT contact you by email or phone, except to verify an order or if we have a issue with your order. We do NOT store any credit card numbers. Any phoned-in, written orders, once processed, are shredded for your privacy.

## Tektosilicate Minerals (Zeolites)

### Analcime



Crystal: Isometric\*  
Pt. Group:  $4/m\bar{3}2/m^*$   
Habit: dodecahedral\*  
SG: 2.3; H: 5  
L: vitreous; Str: white  
Col: white (various shades)  
Clev: weak [100], [010], [001]  
Optics: biaxial (?)\* ; bir=0.0010  
 $n_a=1.479$ ;  $n_b=?$ ;  $n_r=1.48$



<http://webmineral.com>

From the Greek "*adynatos*" meaning weak, referring to a weak electrical charge developed on rubbing



\* inconsistent data; isometric or triclinic?

## Tektosilicate Minerals (Zeolites)

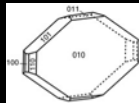
### Heulandite



Crystal: Monoclinic  
Pt. Groups: m, 2  
Habit: blocky to tabular  
SG: 2.2; H: 3 to 3.5  
L: vitreous, pearly; Str: white  
Col: white (reddish, brownish, greyish)  
Clev: perfect [010]  
Optics: biaxial (+) bir=0.003  
 $n_a=1.476$ ;  $n_b=1.479$ ;  $n_r=1.479$



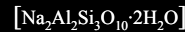
<http://webmineral.com>



Name Derivation: After English mineral collector, John Henry Heuland (1778-1856).

## Tektosilicate Minerals (Zeolites)

### Natrolite



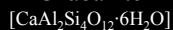
Crystal: Orthorhombic  
Pt. Groups: mm2, (2mm)  
Habit: acicular, bladed  
SG: 2.25; H: 5-5.6  
L: vitreous, silky; Str: colourless  
Col: white (reddish, brownish, yellowish)  
Clev: perfect [110], weak [010]  
Optics: biaxial (+) bir=0.0120-0.0130  
 $n_a=1.473$ ;  $n_b=1.476$ ;  $n_r=1.485$



Name Derivation: From the Greek *natron*, "soda," in allusion to sodium content.

## Tektosilicate Minerals (Zeolites)

### Chabazite



Crystal: Triclinic  
Pt. Group: 1  
Habit: pseudo-cubic, drusy  
SG: 2.09; H: 4  
L: vitreous; Str: white  
Col: white (pinkish, reddish, brownish, greyish)  
Clev: weak [1011]  
Optics: biaxial (+/-) ; bir=0.002-0.005  
 $n_a=1.478$ ;  $n_b=1.480$ ;  $n_r=1.480$   
Occurrence: basalt void-fills

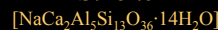


<http://webmineral.com>

From the greek *chabazios*, tune or melody, one of twenty stones named in the poem Peri lithos, which extolled the virtues of minerals.

## Tektosilicate Minerals (Zeolites)

### Stilbite



Crystal: Monoclinic  
Pt. Group: 2/m  
Habit: fibrous (wheat sheaf)  
SG: 2.15; H: 3.5-4  
L: vitreous, pearly; Str: white  
Col: cream, peach, "salmon"  
Clev: perfect [010]  
Optics: biaxial (-) ; bir=0.010-0.013  
 $n_a=1.479$ ;  $n_b=1.485$ ;  $n_r=1.489$   
Occurrence: basalt void-fill



<http://www.ge.mariocopa.edu/earthsci/>

From the Greek *stilbe* - "luster" in allusion to the pearly to vitreous luster.

## Today's Stuff To Do

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1. Posters due NOW
2. Poster Session starts at 1:30 PM
3. Study!

## Next Time

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1. Thanksgiving holiday
2. Next Tuesday: Final lab test