em_notes_2_23

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April 6, 2016

Contents

Earth Materials

1 Continuing Feldspars<*2016-02-23 Tue*>

includes

- granites

- rhylites

2 Techtosilicates

- You can get KSpar in metamorphic rocks, but that's more specialized
  - Potassium Feldspar, not as abundant as plagioclase, but still extremely abundant and common mineral.
  - Kind of like quartz.
  - In general, you need silica-rich Environments, $KAlSi_3$, that's a lot of silica.
  - A felsic rock. Compositionally, we need that felisc composition to get Feldspar
  - very high temperature
  - these things are called granualites
  - metamorphic fomration
  - IN addition to the formula we just covered, often times in KSpar, we can have Fe^{3+} subbing in.
    - It would substitute for Aluminum. 1-for-1
    - when we get this sub in KSpar, it gives it a pink color.
    - most Kspars are a little pink/orange (not found in Plagioclase)
    - Another substitution is Lead - gives a green Amazonite
- All feldspars are very common in sedementary rocks
  - only thing more common is quartz.
  - quartz is just more resistent to weathering
- An Arcose Sandstone
  - A feldspar-rich sandstone. Fairly immature
- Pegmatite
  - All examples we saw in lab with beautiful crystals, those are from pegmatites
  - very water rich environment

- Plagioclase Feldspar
    - its everywhere, ther isn't a rock type you can't get plagioclase from
    - igneous, hydrothermal, .. it's everywhere
    - In more felisc rocks, things tend to be more sodium rich or Albite rich
        * so granite or rhylite. Plagioclase there will be more albite
    - In more mafic rocks, more sodium rich
        * basalt, gavrow, anorthite rich
        * Also generally correspond to tempratures
        * Boen's reaction series (higher T - Mafic, lower T Sodium rich, felsic)
        * Know the Feldspar Triangle
- Techtosilicates

2.1 Zeolite Group

- in terms of variety and # of minerals. The zeolites contain the most different mineral varities of any silicate
- 80 naturally occuring zeolites, more synth'd in a lab
- All zeolites contain structural water. H2O
- Two ways water can be held in minerals
    - Structural water:
        * Molecules of water that live inside the structure
    - Others have OH in their chemistry and get another H when disturbed.
    - Formula: M_x D_y Al. Formula page 1.
    - The ratio of Aluminum to Silica depends on the M-side. They tend to be mono-valent cations
    - D tends to be di-valent cations (Ca, Mn)
    - Structure itself: silicon tetrahedra with long, wide-open tunnels or holes where the water gets in.

- (Na, Ca, H2O) are loosly bound and exchangable in the structure.
  - these make it absorbant
  - Dessecant
  - Na+ -><- Ca^{2+}
- Mineral Use:
  -
- Common Zeolites: (not that important, recognize them as zeolites)
  - Amalcine (Na) Isometric (looks like Leucite, but different size and shape)
  - Chabazite (Ca, Na, u) Triclinic (mixed sort of mineral, triclinic. Looks hexagonal (pseudohexagonal))
  - Heulandite (Na, Ca) Monoclinic
  - Stillbite (Na, Ca) Monoclinic (elongaded, blady sheets)
  - Naturolite (Na) Orthorhombic (radiating fibres)
- Where do zeolites form?
  - Environment is Low-Low Temperature Metamorphism.
  - Hydrothermal Alteration
  - common rocks with a lot of K, Na, Ca (like in feldspar)
  - **Low Temp Alteration & metamorphism, often in mafic rocks**
  - Mafic rocks are very susceptable to low T, hydrothermal alteration
  - They break down and make zeolites.
  - Often fine-grained fillings in cracks or voids, or vesicles.
  - Great place for Zeolites to form.
  - Difficult to identify these fine grains without going to XRD.

silica group feldspar group zeolite group

2.2 Category (Sodalite, Leucite, Nephiline): Feldspathoids

- Like feldspar, but they exist in Low-Si rocks.
  - "Silica-Undersaturated environments"
  - Not enough Si to form Quartz
  - Still have Alkali Elements, those are necessary for Feldspathoids
  - Weird to have that kind of environment.
- Leucite: $KAlSi_2O_6$
  - soccer ball-shaped, roundish crystals
  - Formula looks a lot like KSpar (KAl)
  - Why would we get Leucite instead of KSpar?
    - <write reaction>
    - <Look for Pics>
    - If we low silica rocks/highSilica Rocks
    - lookup (30:00):question:
- Nepheline <complicated formula>
  - Formula for Nepheline
  - Has a little sodium and calcium, not so pure in real world
  - One other Mineral End Membe: Nepheline has complete solid solution to
    - KAlSiO4 (Calcilite), the end of a solid solution.
- Bonus:
  - Two common igneous rock types. Silica undersaturated and have abundant nephaline
  - Phonalite (igneous rocks)
    - pings when you hit it, doesn't break either
    - Si-undersaturated
    - Alkali-enriched
    - Volcanic rock
  - Syenite (the intrusive rock)
    - silica undersaturated, intrusive rock

- Other Feldspathoids (foids):
  - Sodalite: Na8(AlSiO4)6 Cl2 (chlorine, otherwise it's albite)
  - Lazurite:
    - (Na,Ca)8 (AlSiO4)6 (SO4, Cl, S)2
    - Beautiful Azure Blue color
    - Primary constituant of Lapiz Lazuli
  - Petalite: Li(AlSi4O10)
    - society really likes Petalite for it's lithium. We <3 Lithium
    - Hard to find large quantities of Lithium
    - This can be found in Lithium-Rich Pegmatites
    - :question: why does Petalite buck-trends. why unusual?

2.3 Scapolite (it's own little group)

- solid solution between two end members
  - (Marialite) Na4Al3Si9O24Cl
  - (Meionite) Ca4Al6Si6O24(CO3)
  - So, bring in Na, Ca
    - Except for the Cl and the CO3 (carbonate), these look like:
      - very common mineral things are identical to... Plagioclase Feldspars! Anorthite, Albite
    - Scapolite takes the place of Plagioclase Feldspars in a **contact-metamorphic environment**
    - Magma intrusions cause magma intrusions. (Silicate Magma's into a carbonate limestone)
    - CO2 will be burned off into the atmosphere
    - That's where Scapolite forms. It's an indicator of these conditions.
- Keep End-Members Of Solid Solution Paired
  - Mariolite, Myanite
  - (Feldspars): Albite, Anorthite

END OF TECHTOSILICATES ==

3 Phyllosilicates

- Slightly less polymerizatoin of silica
- Construct Phyllosilicates
- There are fundamental structures of phyllosiliates
- **Know the Structure First**
- they're sheet silicates
- Phyllo dough, sheety. fun fact.
- Silicon tetrahedra shares 3 of its oxygens with other silicon tetrahedra. Leaving 1 to bond with other things
- Phyllosilicates are generally soft (1's and 2's) :important:
- Not very dense, fairly open structures () :important:
- Single plane of leavage, easy to identify cleavage :important:

3.1 Structure

- Combination of Tetrahedral Sheets (T)
- and Octahedral Sheets (O)
- Tetrahedral Sheets:
  - Tetrahedral Sites, connected in 2-D Sheet
  - filled with either Al, or Si.
- Octahedral Sheets:
  - Made out of 2 adjacent planes of OH groups.
  - Between which, are a whole bunch of Octahedral, edge-sharing, sites.
- Between these two OH groups, we get our octahedral sites.
  - Filled with Cations
  - Depending on the Cations, there are 2 types of Octahedral Sheets
    * Tri-Octahedral Sheet:

        - 3/3 sites are filled with a 2+ cation (Mg, Fe)
      - Di-Octahedral Sheet:
        - 2 out of 3 sites are filled with 3+ Cation (Al)
        - in the other site, it's vacant

- These building blocks are important:
  1. Tetrahedral Sheets
  2. Tri-Octahedral Sheets
  3. Di-Octahedral Sheets

- Now we glue the different sheets together:
  - Combine T and/or O sheets to make Layers
  - Two Most Fundamental (T is trapezoid) (O is rectangle)
    - (T)(O) Layer
    - (T)(O)(T) Layer
    - (O)... sometimes...
  - Layers are bound together by VanDerWaals or Interlayer Cation

- TABLEL CONSTRUCTION

DiOctahedral	Diagram	Tri-Octahedral	Notes
$Al_2(OH)_6$ Gibsite (ore for Al)	(O)	$Mg_3(OH)_6$ Brucite	These aren't silicates they're hydroxides!
$Al_2Si_2O_5(OH)_4$ Kaolinite (most abundant Clay)	(T) (O)	$Mg_3(Si_2O_5)(OH)_2$ Serpentine swap Al for Mg	
$Al_2Si_4O_{10}(OH)_2$ Pyrophylite w/ VanDerWaals	(T) (O) (T)	$Mg_3Si_4O_{10}(OH)_2$ Talc	
$KAl_2(AlSi_3)O_{10}(OH)_2$ Muscovite (kendmember) $NaAl_2(AlSi_3)O_{11}(OH)_2$ Paraganite	+ (T) (O) (T) +	$KMg_3(AlSi_3)O_{10}(OH)_2$ Biotite	 MICAS: (TOT) w/ interlayer cation
$Ca(Al_2)(Al_2Si_2)O_{10}(OH)_2$ Margarite	2+ (T) (O) (T) 2+		
	(Talc) (Brucite) (Talc)	 Chloride 3rd most common phyllosilicate	

:question: about K end member in the table
Look at page 5 for the phengite information... Ask :question: about it.

4 Phyllosilicates Continued *<2016-02-25 Thu>*

- Phyllosilicates cont.
- Phengite
  - similar to muscovite, but it takes the place of muscovite at High Pressures
  - $K(Al_2)(AlSi_3)O_{10}(OH)_2$ (Muscovite)
    - Add some Mg^{2+} and some Si for Al and creates Phengite
    - (4si/4Al) = (3/1)

        * Phengite is a really common indicator of ultra-high pressure/conditions

- Paragonite is muscovite except remove K and put in Na

4.1 Quick Review and Finish Up

4.1.1 Micas

- TOT + interlayer Cations
- Biotite:
    - **2 end members (Fe^{2+} Anite), (Mg^{2+} Phlogopite)**
    - Common Brown Mica, can get it everywhere
    - Need a lil Mg and Fe and a Na
- Muscovite (one end member) :question:
    - Silvery/clear
    - restricted to felsic, igneous, metamorphic, and sedementary derivatives
- Paragonite:
    - Na-rich
    - Higher Pressure Mica
    - Paragonite, like Phengite, is an indicator of High Pressure
    - sometimes, paragonite is more white than muscovite's silvery whitish color
- Phengite:
    - Si-rich, high pressure
- Muscovite, Paragonite, Phengite can be called "White Mica"
- Glauconite:
    - green mica, because Fe^{3+}
    - Often fine grained in marine sedimentsf

END MICAS

4.2 Other Phyllosilicates

- Chlorite:
  - Dark Green
  - low-temperature metamorphic rocks
  - hydrating mafic protoliths
  - Mafic Protoligh (basalt)
  - Green Schist/Green Stone is green becasue of chlorite
  - looks like a mica
  - forms with the micas, muscovite & friends
  - How to tell Chlorite from others Micas ?:
    - Micas are Elastic, Chlorite isn't. (+ color)
- Talc:
  - soft, greasy, fun to look at
  - Common in hydration of mafic to UltraMafic rocks
  - Hydration, Low-T metamorphism of ultramafic rocks
  - Water added to Basalt, but you need "Ultra"mafic protolith such as:
    - the mantle!
  - Inject water into the mantle and you'll make things like Talc
  - Or Serpentine!!
- Serpentine
  - Common in metamorphic hydration (add water to mantle, will make Talc, Brucite, Serpentine)
  - Is a fun one:)
  - Very water rich. It has an incredible solid storehouse of water. Up to 15% weight in water.
  - 3 Different Crystal forms Serpentine can take :important:
  - They're serpentine chemicallly and structurally.
  - Serpentine is a (T)(O) structure. But it can bend to fit things together. Bent Sheets (see page 1).

        * Lizardite: random ordering of bent TO's. Massive texture.
        * Antigorite: Ordered, wavy formation.
        * Crysotile: Ordered, in a circle. That's where we get the needles. Sheet Needle.
            · Asbestos form of Crysotile, and of Serpentine
            · It's not structurally a needle, it's a sheet.
            · not as bad as amphibole asbestos

4.3 Clay Minerals

- XRD needed to identify the Clay Minerals
- sedementology - "clay" is anything finer than a grain size :question:
- mineralology - "clay" is a phylosilicate tends to be fine grained.
- Two Broad categories of Clay Minerals

4.3.1 1:1 Clays

(T)(O) ex: Kaolinite

- strictly speaking, serpentine counts here. But it doesn't form in the same environment so we don't count it.

4.3.2 2:1 Clays

(T)(O)(T) ex: (**don't have their own formula, know that they're 2:1 clays, and that Smectite, Verm, and Montmor. form due to weathering of Mafic Rocks have a property of shrinking and swelling due to water uptake in the interlayer regions**)

- Smectite (includes some mix of Ca, Mg, Fe in the octahedral sites)
- Vermiculite
- Montmorillionite
- Illite (brings in K, similar to muscovite)
- **Kaolinite and Illite form from weathering of Felsic Rocks**
    - that's a big deal

- We could add Glauconite (K, Fe^{3+}) to the mix.
  - Often forms as a Clay in marine, sedimentary environments
  - sediment binds them
- **Smec, Verm, Montor. they expand and dessicate with water. By like 50%!!! That's huge**
- **Because they're so fine grained, you can't identify these potential dangers unless you resort to XRD**

END OF PHYLLOSILICATES ==

5 Inosilicates

- Two types:
  - single chain silicates = pyroxenes. pyroxenes are single chain silicates. the end.
    - End in SiO_3
  - Dobule chiain silicates = amphiboles.
    - End in Si_8O_{22}

5.1 Pyroxenes

- LEARN THE STRUCTURE FIRST!!!, just like with the phyllosilicates
- And amphibole can get ugly formula-wise, so learn by structure first
- like feldspar with triangle, learn the triangle and use structure

5.1.1 Structure of Pyroxenes

- silicon tetrahedron's sitting flat on the board, stacked end to end. C-axis. Page 2.
- Along C-Axis view: $\Delta\Delta\Delta$