

Geology 284 - Mineralogy, Fall 2009

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## Mineral Classification

There are many possibilities

- "biological type" classification (genus & species?)
- Linneaus tried in 1768, but it's unsatisfactory for minerals
- "petrologic" classification
  - igneous minerals                      textbook organization
  - sedimentary minerals
  - metamorphic minerals
- classification by properties
  - This is what we use in lab (by luster, hardness, streak, etc.)

in the **Mineralogist's classification (after J. D. Dana, 1837)**

Minerals are grouped by their **dominant anion** or **anionic complex** (Table 2.5

Perkins and handout)

- The group to which a mineral belongs can be told directly from the chemical formula
- Minerals with the same anion tend to have similar properties
- Minerals with the same anion tend to occur together in the same geologic environment

| <b>Mineral Class or Group</b> | <b>Anion or Anionic Group</b> |
|-------------------------------|-------------------------------|
|-------------------------------|-------------------------------|

|                 |          |
|-----------------|----------|
| Native elements | no anion |
|-----------------|----------|

Ex: gold      Au

|          |    |
|----------|----|
| Sulfides | S* |
|----------|----|

Ex: galena      PbS

|            |            |
|------------|------------|
| Sulfosalts | S, As, Sb* |
|------------|------------|

Ex: niccolite      NiAsS

\*bonding is mostly metallic, so there is no true anion, therefore, no charge is given

|         |   |
|---------|---|
| Halides | Cl <sup>-</sup> , F <sup>-</sup> , Br <sup>-</sup> , I <sup>-</sup> |
|---------|---|

Ex: fluorite      CaF<sub>2</sub>

Ex: halite      NaCl

|        |                 |
|--------|-----------------|
| Oxides | O <sup>2-</sup> |
|--------|-----------------|

Ex: magnetite Fe<sub>3</sub>O<sub>4</sub>

Hydroxides

$\text{OH}^-$

Ex: brucite  $\text{Mg}(\text{OH})_2$

These have "simple" anions - approximately spherical

Carbonates

$(\text{CO}_3)^{2-}$

Ex: dolomite  $\text{CaMg}(\text{CO}_3)_2$

Nitrates

$(\text{NO}_3)^{1-}$

Ex: niter  $\text{KNO}_3$

Borates

$(\text{BO}_3)^{2-}$  or  $(\text{BO}_4)^{5-}$

Ex: sinhalite  $\text{MgAlBO}_4$

These have triangular-shaped complex anions

Sulfates

$(\text{SO}_4)^{2-}$

Ex: anhydrite  $\text{Ca}(\text{SO}_4)$

Phosphates

$(\text{PO}_4)^{3-}$

Ex: apatite  $\text{Ca}_5(\text{PO}_4)_3(\text{OH})$

Silicates

$(\text{SiO}_4)^{4-}$

Ex: quartz  $\text{SiO}_2$

These have tetrahedral complex anions

Sketch the shape of a tetrahedron

**Because there are so many (>800) important silicate minerals in rocks**

**and Because silicate minerals are polymerized in many different ways**

**The silicates are classified separately and are subdivided**

**based on how the  $\text{SiO}_4^{4-}$  tetrahedra are polymerized (stuck together)**

**Silicate Mineral Subclasses (See Table 2.6 (Perkins) and handout)**

Isolated tetrahedral silicates (nesosilicates or orthosilicates)

- # corners shared      none
- Si,O formula       $(\text{SiO}_4)^{4-}$
- Si:O ratio      1:4
- Example      olivine

- Formula  $\text{Mg}_2\text{SiO}_4$

### Paired tetrahedral silicates (sorosilicates)

- # corners shared 1/tetrahedron
- Si,O formula  $(\text{Si}_2\text{O}_7)^{6-}$
- Si:O ratio 2:7
- Example ackermanite
- Formula  $\text{Ca}_2\text{MgSi}_2\text{O}_7$

### Ring silicates (cyclosilicates)

- # corners shared 2/tetrahedron
- Si,O formula  $(\text{Si}_6\text{O}_{18})^{12-}$
- Si:O ratio 6:18
- Example beryl
- Formula  $\text{Be}_3\text{Al}_2\text{Si}_6\text{O}_{18}$

You can draw simple sketches and count Oxygens, Silicons, corners, etc.

### Single chain silicates (inosilicates)

- # corners shared 2/tetrahedron

- Si<sub>2</sub>O formula             $(\text{SiO}_3)^{2-}$  or  $(\text{Si}_2\text{O}_6)^{4-}$
- Si:O ratio                1:3, 2:6
- Example                 diopside (a pyroxene)
- Formula                  $\text{CaMgSi}_2\text{O}_6$

### Double chain silicates (inosilicates)

- #corners shared         $\frac{1}{2}$  two,  $\frac{1}{2}$  three
- Si<sub>2</sub>O formula             $(\text{Si}_8\text{O}_{22})^{12-}$
- Si:O ratio                4:11, 8:22
- Example                 tremolite (an amphibole)
- Formula                  $\text{Ca}_2\text{Mg}_5\text{Si}_8\text{O}_{22}(\text{OH})_2$
- Hydrous (contains OH<sup>-</sup>)

### Sheet silicates (phyllosilicates)

- #corners shared        3/tetrahedron
- Si<sub>2</sub>O formula             $(\text{Si}_4\text{O}_{10})^{4-}$
- Si:O ratio                2:5, 4:10
- Example                 kaolinite
- Formula                  $\text{Al}_2\text{Si}_4\text{O}_{10}(\text{OH})_2$
- Hydrous (contains OH<sup>-</sup>)

### Framework silicates (tectosilicates)

- #corners shared        4/tetrahedron

- Si,O formula  $(\text{SiO}_2)^0$  or  $((\text{Al},\text{Si})_4\text{O}_8)^{1- \text{ to } 2-}$
- Si (±Al):O ratio 1:2
- Example quartz, K-feldspar
- Formula  $\text{SiO}_2, \text{KAlSi}_3\text{O}_8$