Mineral Properties

Descriptive Mineralogy
(non-destructive methods)

How do we define a mineral?

- Naturally occurring
- Stable at room temperature
- Inorganic
- Can be represented by a chemical formula
- Has an ordered atomic arrangement

This definition of a mineral is the template by which we can establish the rules for:

1)Which of the elements do we select to build minerals = *crystal chemistry*

2) How are those elements arranged = *crystallography*

Crystal Morphology

Crystals are formed by repetition of smallest division of their unique unit of structure….. **The unit cell**

The limiting faces of the crystal, and subsequently a crystals form/morphology are a reflection of this unit cell

Although other factors can influence final form and composition (temperature, pressure, growth rate…..)

This means that some physical properties are consistent and fixed, while others vary

Of the ~90 naturally occurring elements recognized, 8 of these make up all but ~2% of the constituents of the Earth's crust

By weight %, oxygen is by far the most dominant and is one of the most important anions in the study of terrestrial rocks

Cations make-up the other 7 major elements that have 4 different valance states – one of the through-going themes in mineralogy is the study of how oxygen bonds with different cations

As the charge of a cation decreases, the size increases meaning that a larger number of oxygens are needed to make a space for the cation

Increasing the number of oxygens from 4 (i.e. the silica tetrahedra) is an increase in the ***coordination number***

Nevertheless, charge is not the only factor in determining coordination, P and T conditions also play a significant role

Crystal morphology, crystallography and crystal systems

"Crystal systems" is simply a way of describing and categorizing the organization of atoms in a mineral

Using this system of classification we can describe not only what the coordination is, but where atoms are located

In crystallography, we used a system based on the *x, y, z* Cartesian coordinate system, but modified slightly to allow for different lengths and angles between the three points of the **basis vector set**

In crystallography: x, y, z = a, b, c

- Isometric (cubic): minerals with the same physical properties in all directions

- Tetragonal: one pair of orthogonal axes, c-axis is unique, with all three angles between the axes = 90°

- Hexagonal: one pair of orthogonal axes, c-axis is unique, with the angle between the a and b axes (γ angle) = 60° or 120°

- Orthorhombic: no axes lengths are the same, but the angles between the axes are all 90°

- Monoclinic: no axes lengths are the same, but 2 of the angles are 90°

- Triclinic: no 2 axes or angles between axes are the same

Optical classes

The characteristics of each of the three optical classes are directly related to the crystal systems

The optical classes are structured based on the way in which light interacts with the mineral structure

Isotropic: isometric minerals

Anisotropic

-Uniaxial: tetragonal and hexagonal minerals

-Biaxial: orthorhombic, monoclinic, & triclinic system

The importance of Si + O

Silica and oxygen provide the structure which is one of the foundations for the most common minerals on earth

This is related to the versatility of the silica tetrahedra to bond with other cations in different coordination states

The goals is to satisfy 2 main criteria:

1) maintain charge balance and sum to zero

2) achieve structural equilibrium – there must be the right amount of space for cations of a certain size

Mineralogy term paper

Topic can be anything you choose that is related to the study or application of minerals in academics, industry, applied science, etc.

Majority of sources must be from scientific journals or texts. The web can be a good place to start, but cannot be used as the sole source of references.

First due date is Monday September 15: topic with initial research behind the idea including references

QUIZ MONDAY SEPTEMBER 8 on the big 10 minerals and 6 crystal systems