

GEOL 3010 Mineralogy Fall, 2009

Introduction

Logistics

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Prerequisites

- *Math - First semester calculus or equivalent*
 - *ln, e^x, sin, cos, tan, etc.*
- *Chemistry - First semester*
 - *Periodic Table, formulas, balancing reactions, isotopes*
- *Computers*
 - *MSWord, Excel, or equivalents*

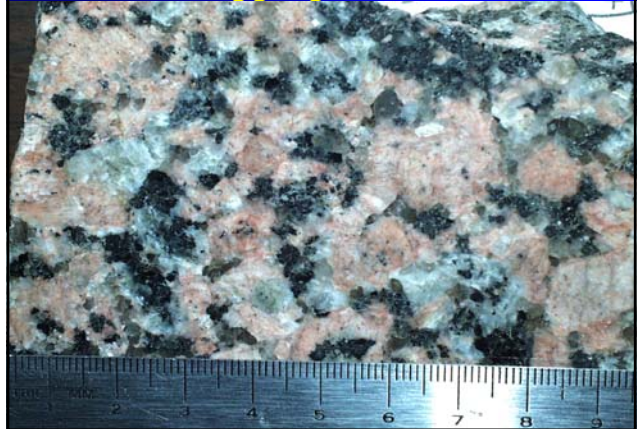
Why Study Minerals?

- *Minerals are the way atoms are arranged in rocks.*
- *Atomic environments in rock are homogeneous from the mm scale to the Å scale (7 orders of magnitude).*
 - *1Å = 10⁻¹⁰ m = 10⁻⁷mm*
- *Mineralogy is solid-state geochemistry.*

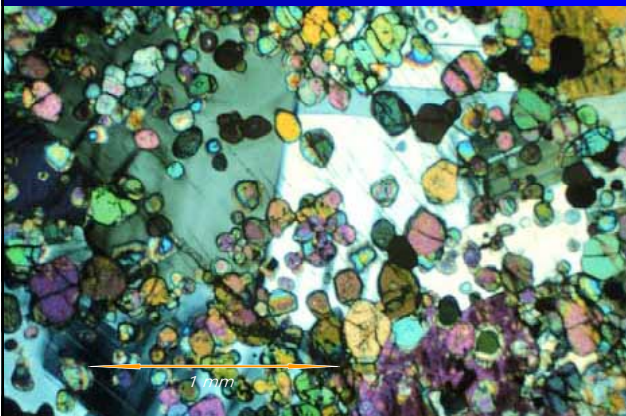
Why Study Minerals?

- *Minerals are fundamental to Earth Sciences.*
 - *Environmental sciences*
 - *Geochemistry*
 - *Geophysics*
- *Mineralogy is a mature science.*
- *Mineralogy is primarily a tool for understanding the Earth*

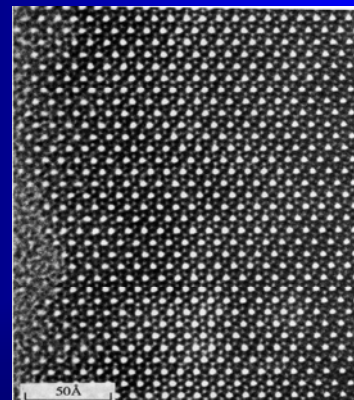
Rocks are aggregates of minerals.



Rocks are aggregates of minerals.



Minerals are homogeneous down to atomic scale.



Definition of a Mineral

- *A mineral is a naturally occurring,*
- *homogeneous solid with a*
- *definite, but not fixed, composition, and*
- *an ordered atomic arrangement that is*
- *formed by inorganic processes.*

- *A mineral is a natural, crystalline phase.*

Minerals are Naturally Occurring

- *In order to be a mineral, a chemical compound must occur naturally somewhere and be stable enough to study in the lab.*
- *We can make many compounds in the lab that are not minerals unless they are found in nature.*

Mineral are homogeneous

- *Minerals are chemically homogeneous down to the atomic scale.*

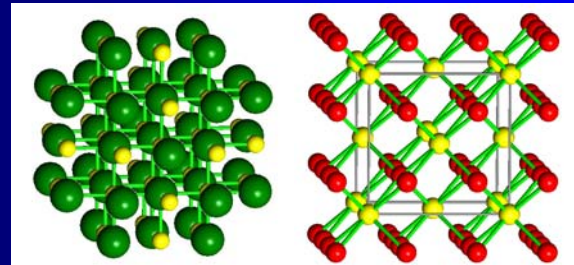
Definite, but not fixed, composition.

- *Minerals have chemical formulas determined by the atomic structures.*
- *Symmetry requires atoms to occur in simple, specific, integer ratios.*
- *But, for a given mineral, substitutions of similar elements are possible.*

Ordered atomic arrangement

- Minerals are crystals (crystalline solids).
- Crystals are periodic arrays of atoms.
- Atoms achieve their lowest energy by having each different type of atom (element) in an identical environment.

Ordered atomic arrangement



Halite (NaCl)

Fluorite (CaF₂)

Inorganic Processes

- The mineral must have at least one occurrence where it is formed by inorganic processes.
- Calcite may be formed by organisms to form shells, but it also occurs in igneous and metamorphic environments.

These are Minerals

- Gold, silver, diamond, graphite
- Pyrite, marcasite, sphalerite
- Salt (halite), fluorite, calcite, apatite
- Olivine, garnet, zircon
- Pyroxene, amphibole, mica
- Quartz, feldspar, zeolite

These natural solids are NOT Minerals

- *Granite, basalt, limestone*
– *(These are rocks, composed of minerals)*
- *Wood, coal*
– *(organic, non-crystalline solids)*
- *Opal, obsidian, pumice*
– *(glass, non-crystalline solids)*

Polymorphs and Isomorphs

- *Polymorph:*
same composition, different structure
- *Isomorph:*
same structure, different composition

Polymorphs

- *Two minerals with the same composition, but different structures are different minerals.*
- *Diamond and graphite are both pure carbon, but are different minerals*
- *Quartz-tridymite-cristobalite-coesite-stishovite: all polymorphs of SiO_2 .*
- *Calcite and aragonite are CaCO_3 .*
- *This is why we use mineral names rather than chemical formulas.*

Isomorphs

- *Minerals with the same structure and different compositions are **isomorphs**.*
 - *Forsterite (Mg_2SiO_4)- fayalite (Fe_2SiO_4)*
 - *Halite (NaCl) - sylvite (KCl), periclase (MgO), galena (PbS)*
 - *Gold (Au) - silver (Ag)*
 - *Quartz (SiO_2) - berlinite (AlPO_4)*
 - *Muscovite-Biotite*
- *Sometimes there's crystalline solution, sometimes not.*

Mineralogy Today

- *Mineralogy is a mature science*
 - *10 to 20 new species each year*
 - *About 5000 total species*
- *Mineralogy is primarily a tool for understanding the Earth.*

Mineralogy Today

- *Mineralogy is the study of natural crystalline solids.*
- *Geophysics*
 - *Mineral Physics*
- *Geochemistry*
 - *Igneous, sedimentary, Metamorphic*
 - *Ore deposits*
 - *Environmental*
 - *Biogeochemistry*