EPS 39A

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• Be sure your name is on the list. Check if e-mail is correct

• Check your name on the list. There may be openings for waiting list.

• If your name is not on the list or if you have any questions, see me after class.

• Be sure to return at the latest next week the Liability Waiver and the Personal Data Sheet.
Meetings (all must attend):

- Feb. 4, 5 p.m. Geology of California
- March 15, 5 p.m. Logistics of field trip
- April 23-26, start 7 a.m. 4 day field trip
- May 4: Two page report
Supernova 1987A Rings

Hubble Space Telescope
Wide Field Planetary Camera 2
CO + 3H₂ ±10% volatilized silicates

Condensation of planetesimals
10² - 10⁴ cm

MANTLE

SOLAR WIND
Hot PTA

Ca, Al oxides

Volatiles (smoke)
Na, K, Pb, Zn, S, Cl, etc.

Mg,Fe silicates

Dissipation of PTA + smoke

SOLAR NEBULA
(Mainly H₂)

Rapidly rotating earth + PTA

2000 °C
A Dynamic Earth
Minerals: chemically and structurally homogeneous constituents of the earth

Crystals: Solid materials with a regular atomic structures

Rocks: composed of minerals
Quartz SiO$_2$
Garnet $\text{Fe}_3\text{Al}_2\text{Si}_3\text{O}_{12}$
Structure of Halite  NaCl
(ionic bonding)
High resolution transmission electron microscope image of gold
Important minerals:

- Gold, Au
- Diamond, Graphite, C
- Halite (Salt), NaCl
- Pyrite, FeS$_2$
- Quartz, SiO$_2$
- Feldspar, NaAlSi$_3$O$_8$
- Mica, KAl$_2$(AlSi$_3$O$_{10}$)(OH)$_2$
- Olivine, Mg$_2$SiO$_4$
Snow crystals
Conditions affecting morphology of snow crystals
Chemical Classification of Minerals

Elements (gold, diamond)
Halides (halite)
Carbonates (calcite) $XCO_3$
Phosphates (apatite) $XPO_4$
Sulfates (gypsum) $XSO_4$
Oxides (quartz) $XO$
Sulfides (pyrite) $XS$
Silicates (olivine, feldspar, mica) $XSiO_4$
Fricot gold nugget
Si-O bond partially covalent: low symmetry!
Sheetsilicates have sheets of Si-O tetrahedra
Sheets of Si-O tetrahedra bonded to sheets of octahedra

Triocahedral (Mg, Fe)  
Biotite

Dioctahedral (Al)  
Muscovite
Brucite
Gibbsite
Serpentine
Kaolinite
Talc
Pyrophyllite
Biotite
Muscovite
Chlorite

Mg
Al
Chrysotile asbestos
Chrysotile asbestos
Apatite $\text{Ca}_5(\text{PO}_4)_3\text{ (OH)}$
Apatite: Rat tooth enamel
Important rocks:

Volcanic rocks: e.g. basalt (olivine, feldspar)
Plutonic rocks: e.g granite (feldspar, quartz, mica)
Sedimentary rocks: e.g. chert, sandstone (quartz), limestone (calcite)
Metamorphic rocks: e.g. schist (mica, quartz, feldspar)
Igneous Rocks

Volcanic rocks

Plutonic rocks
Distribution of volcanoes
Mount Fuji, Japan ~ 100,000 years
Stromboli
Cerro Negro
Nicaragua
1968
Columnar basalt
Geysers, California: 60% of N-Coast power needs
Plutonic rocks
Classification of granites
Granite with inclusions (xenoliths)
Thin section of granite: plagioclase, quartz, biotite
Sedimentary rocks

- Evaporites
- Carbonate rocks (limestone)
- Sandstones
- Conglomerates
- Shales etc.
calcite → gypsum, anhydrite → halite (NaCl) → sylvite (KCl)
Carbonate rocks
Volcano rises from ocean floor

Eroded extinct volcanic island

Fringing reef

Volcano extinct; fringing reef forms

Barrier reef

Lagoon

Remnant of volcanic island

Subsidence of plate and volcanic island as reef builds up

Continued subsidence; reef completely covers buried volcanic island
Diatom (Calcite)
Foraminifera and other organisms secrete calcium carbonate in surface water.

Shells of dead organisms settle after death.

Deep-water zone of carbonate dissolution.

Carbonate sediment.

Mid-ocean ridge.
Metamorphic rocks
Some reactions:

With temperature (contact of granite and limestone):
\[ \text{CaCO}_3 \text{ (Calcite)} + \text{SiO}_2 \text{ (Quartz)} \rightarrow \text{CaSiO}_3 \text{ (Wollastonite)} + \text{CO}_2 \]

With pressure (mantle):
\[ \text{Mg}_2\text{SiO}_4 \text{ (Olivine)} \rightarrow \text{MgO} \text{ (Periclase)} + \text{MgSiO}_3 \text{ (Perovskite)} \]
$\text{Al}_2\text{SiO}_5$
KAl₂AlSi₃O₁₀(OH)₂ + SiO₂ →
Muscovite   Quartz
Al₂SiO₅    + KAlSi₃O₈ + H₂O
Sillimanite  K-feldspar  Water
Breakdown of muscovite to form K-spar and sillimanite
James Hutton 1795