Alkaline earth metals

- The alkaline earth metals are reactive compared to most metals. However, they are less reactive (as a group) than the alkali metals
- They have relatively high melting points and densities when compared to the alkali metals

Physical properties

Common features

- Most compounds of the alkaline earth metals are ionic and colorless
  - Most beryllium compounds and several magnesium compounds are covalent
- The simple slats of M^{2+} cations tend to be hydrates

Solubility

- Unlike the alkali metals, many alkaline earth containing compounds are insoluble
  - $BaSO_4$, MgO etc.
- Depends upon charge on anion and size match between anion and cation
  - like the alkali metals solubility is determined by a balance between lattice and hydration thermodynamic terms
    - » for M^{2+} both lattice energies and hydration enthalpies tend to be larger

Beryllium

- Forms largely covalent compounds due to the large charge density of Be^{2+}
- Extracted from Beryl, $Be_3Al_2Si_6O_{18}$
- Used in the manufacture of precision instruments
  - non-magnetic, corrosion resistant, low density
- Used in production of X-ray windows

Beryllium

- Beryllium compounds are very toxic
- Beryllium is amphoteric (unlike the other alkaline earth metals)
  - BeO dissolve sin both acid and base
  - $H_2O + BeO + 2H_3O^+$ ----> $[Be(OH_2)_4]^{2+}$
  - $H_2O + BeO + 2OH^-$ ----> $[Be(OH)_4]^{2-}$

Magnesium

- Magnesium is widely used in low density Al/Mg alloys for mass critical applications
- Extracted by electrolysis from $MgCl_2$
  - obtained indirectly from sea water
- Mg is thermodynamically very reactive
  - however, oxide layer protects it
- Forms organometallic with covalent bonds
  - Grignards

Oxides

- All the alkaline earth metals react with O_2 to forms simple oxides with the exception of barium - forms some peroxide
- Solubility varies widely
  - MgO insoluble, highly refractory
  - CaO sparingly soluble, thermoluminescent
  - SrO and BaO readily soluble

Hydroxides

- $Mg(OH)_2$ - “Brucite” is insoluble. This makes it valuable in the preparation of antacids
- $Ca(OH)_2$ is sparingly soluble. It reacts readily with CO_2 to from a carbonate. At high CO_2 levels in water a soluble hydrogen carbonate can be formed
  - basis of cave formation and stalactite and stalagmite formation

Cement

- Cement is formed by reacting calcium carbonate with aluminosilicate minerals at high temperatures
  - get mix of Ca_2SiO_4, Ca_3SiO_5 and $Ca_3Al_2O_6$
- Hydration processes lead to setting
  - $2Ca_2SiO_4 + 4H_2O \text{ ---> } Ca_3Si_2O_7.3H_2O + Ca(OH)_2$
  - hydrate binds to added sand and aggregate

Calcium carbide

- CaC_2 has a rock salt (NaCl) structure with C_2^{2-} ions on the chloride sites
  - formed by high temperature reaction of coke and calcium oxide
- The reaction of calcium carbide with water is an important source of acetylene
  - $CaC_2 + 2H_2O \text{ ---> } C_2H_2 + Ca(OH)_2$

Diagonal relationship

- Beryllium and aluminum have a number of chemical similarities due to their similar charge densities
- Both form protective oxide coatings
- Both elements are amphoteric
- Both form carbides containing the C^{4-} anion
  - gives methane on reaction with water

Biological aspects

- Mg^{2+} plays a key role in photosynthesis
- $CaCO_3$ is used in the formation of shells
- Hydroxyapatite [$Ca_5(OH)(PO_4)_3$] is a key constituent of bone.