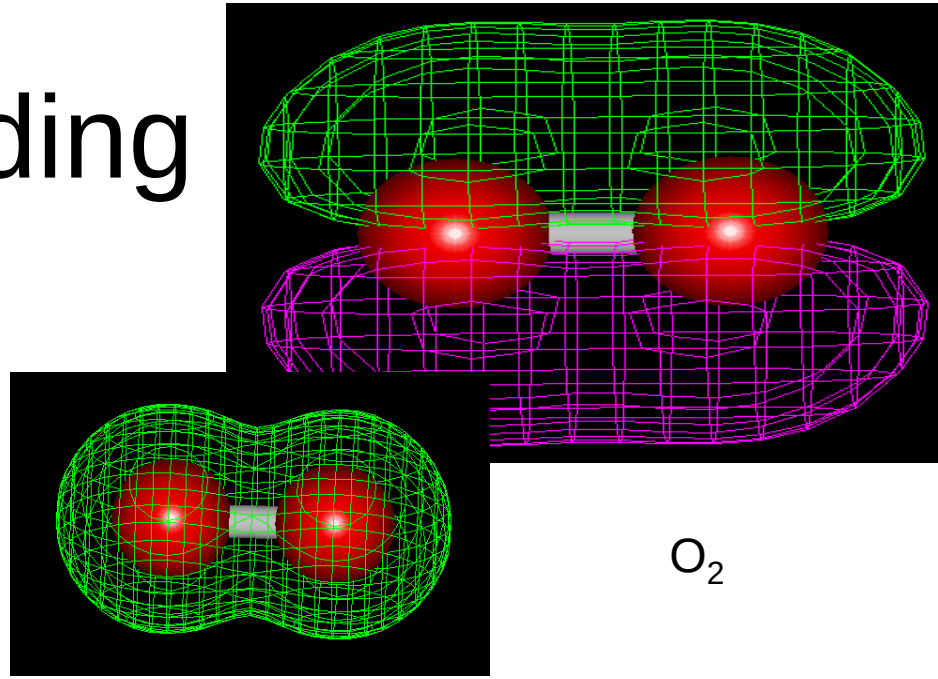
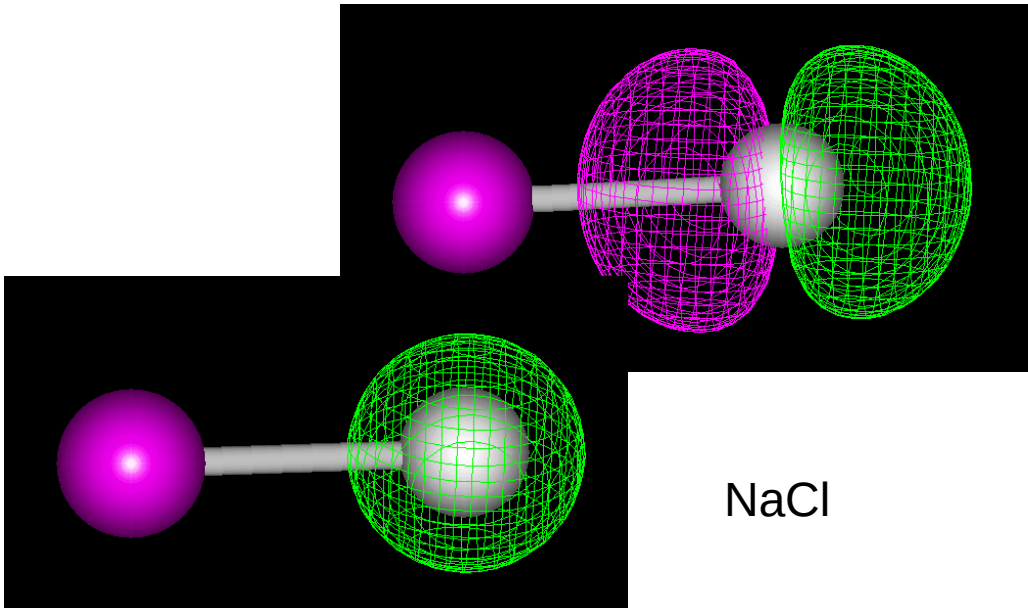
Bonding

- Atoms come together in one of 3 principle types of bond
  - Ionic = + and - ions (charged atoms) joined by an electrostatic interaction
  - Covalent = Sharing of electrons equally between ions
  - Metallic – sharing of electrons between many atoms



O_2



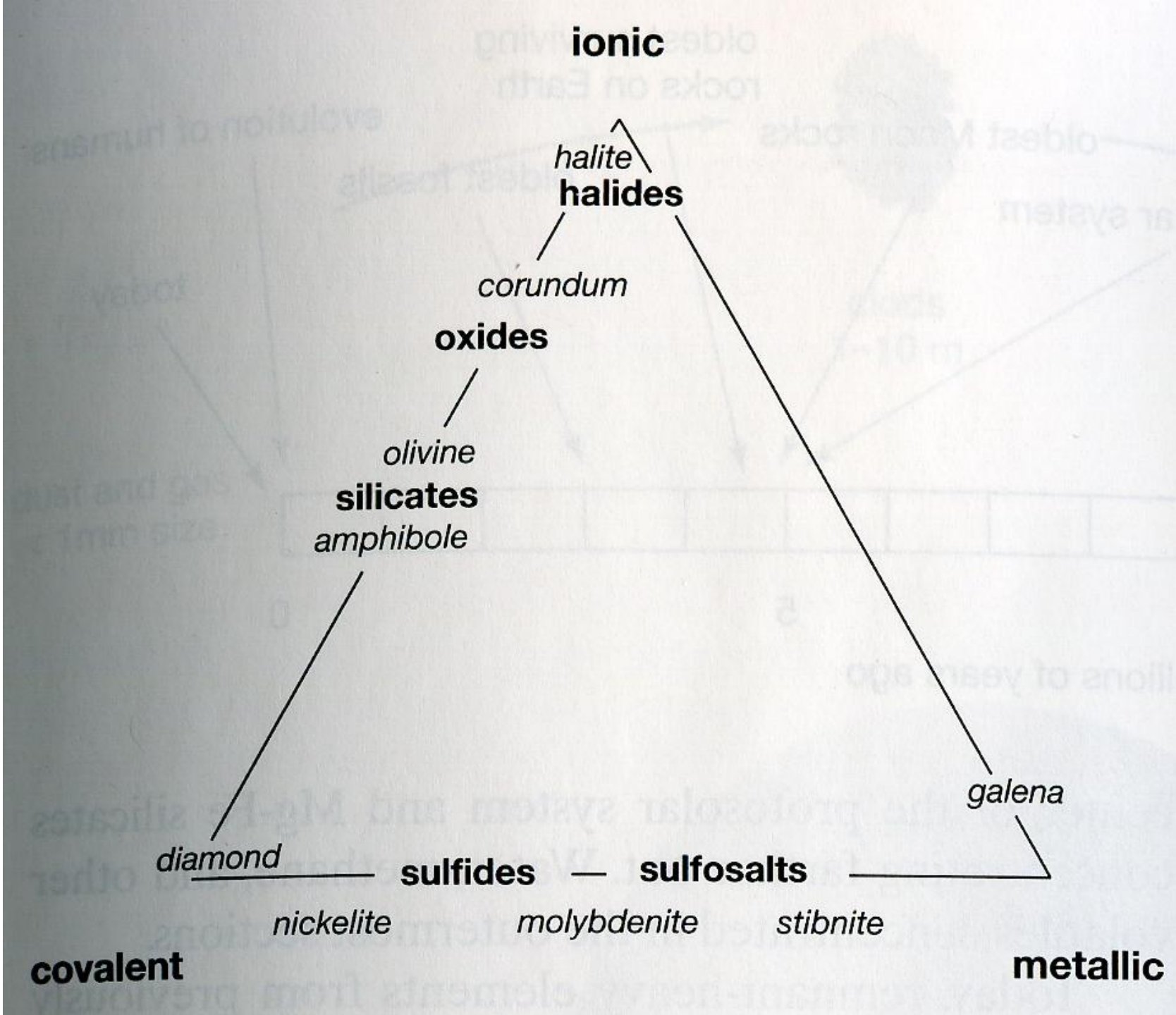
NaCl

Ionic vs. Covalent

- Elements on the right and top of the periodic table draw electrons strongly
- Bonds between atoms from opposite ends more ionic, diatomics are 100% covalent
- Bond strength → Covalent>Ionic>metallic
  - Affects hardness, melting T, solubility
- Bond type affects geometry of how ions are arranged
  - More ionic vs. covalent = higher symmetry

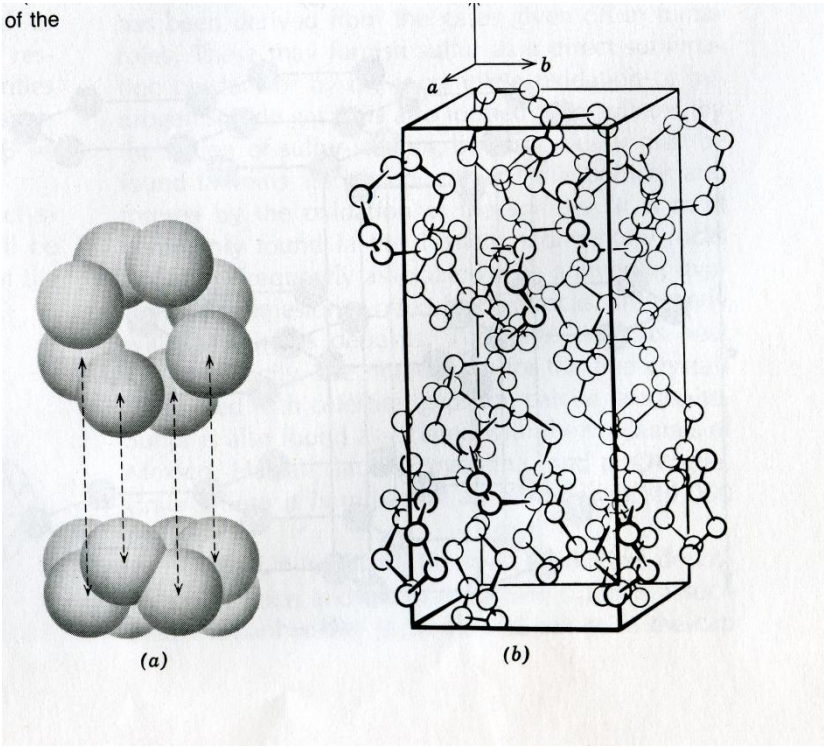
Metallic Bonds

- Electron sharing can go in any direction – results in more malleable material
- Also affects electronic properties – metallic materials conduct electricity better
- Affects redox reactions – where there is a transfer of electrons as a part of dissolution
- electrons are nonbonding or delocalized, which makes materials less polar – and thus less soluble is water


ionic
halite
halides
corundum
oxides
olivine
silicates
amphibole
galena
diamond
sulfides
sulfosalts
nickelite
molybdenite
stibnite
covalent
metallic

Other types of bonding

- Van der Waals – Interaction between molecular units which assemble a mineral from weak electrostatic interactions
- Hydrogen – H^+ bonds molecular subunits together
- Dative – special type of covalent bond – all bonding electrons donated by one ion



Ionic bonding

- Most common minerals on earth are composed of ionic bonds
- Covalently bonded anionic subunits are often ionically bonded to cations to form these minerals – SiO_4^{4-}, CO_3^{2-}, PO_4^{3-}, SO_4^{2-}
- Mineral properties are more often compared by the anionic component, thus most classification schemes focus on this.

Ionic vs. Covalent

Bond strength → Covalent>Ionic>metallic

- Affects hardness, melting T, solubility

- Bond type affects geometry of how ions are arranged
  - More ionic vs. covalent = higher symmetry

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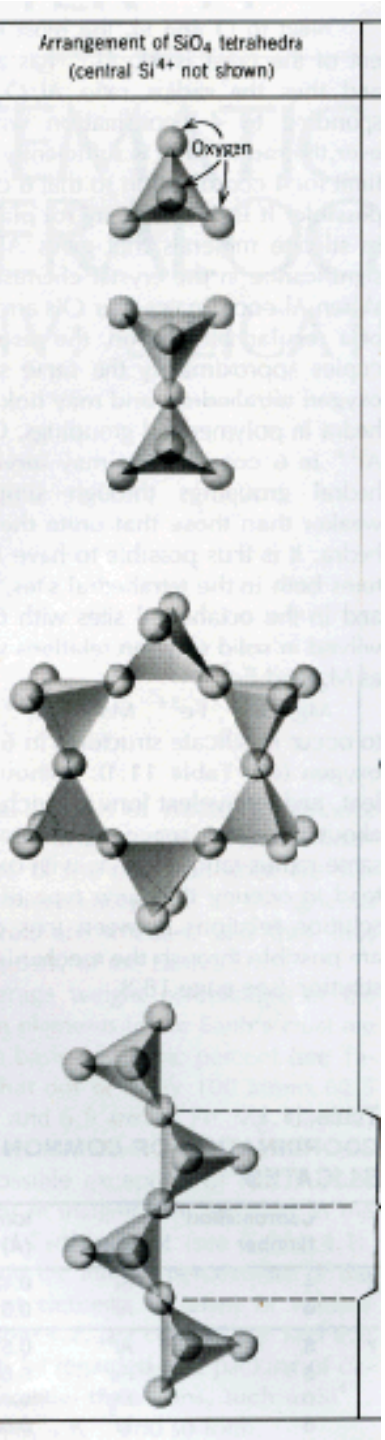
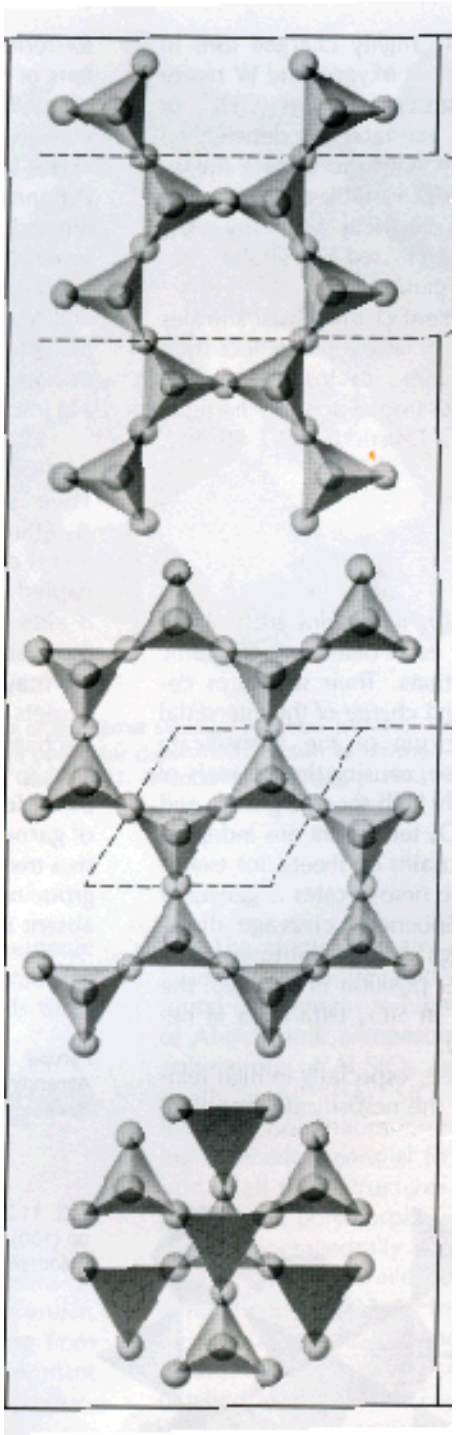


Nesosilicates
– SiO_4^{4-}

Sorosilicates
– $Si_2O_7^{6-}$

Cyclosilicates
– $Si_6O_{18}^{12-}$

Inosilicates
(single)
– $Si_2O_6^{4-}$



Inosilicates
(double)
– $Si_4O_{11}^{6-}$

Phyllosilicates
– $Si_2O_5^{2-}$

Tectosilicates
– SiO_2^{0}