Lecture Notes - Mineralogy - Closest Packed Structures

Using tennis balls we discussed three possible packing arrangements of spheres: cubic closest packing (X^c), hexagonal closest packing (X^h), and simple cubic packing (X^{sc}). The pattern of anion packing in many simple ionic crystals and common minerals follows one of these packing arrangements with cations in octahedrally coordinated holes (A^o), tetrahedrally coordinated holes (A^t), or simple cubic coordinated holes (A^{cb}). Differences among the resulting structures are due to the relative charges on and radii of the anion(s) and cation(s) involved and, therefore, which cation sites ("polyhedral holes") are occupied. A number of examples are given by Bloss (Chap. 9) including:

| | | | | Electro- | |
|---|---------------------|----------------|---------------------------------------|------------|---------------|
| <u>Structure</u> | <u>Formula</u> | <u>Mineral</u> | $\underline{R}^{+}/\underline{R}^{-}$ | negativity | <u>%Ionic</u> |
| A°X ^c | NaCl | halite | .54 | 2.23 | 71 |
| | MgO | periclase | .47 | 2.13 | 68 |
| | PbS | galena | .65 | 0.25 | 02 |
| $A^{\scriptscriptstyle O} X^{\scriptscriptstyle h}$ | NiAs | niccolite | | 0.27 | 02 |
| | Fe _{1-X} S | pyrrhotite | .40 | 0.75 | 14 |
| A ^{cb} X ^{sc} | CsCl CsBr | | .92 | 2.37 | 75 |
| $A^t X^c$ | ZnS | sphalerite | .40 | 0.93 | 20 |
| $A^t X^h$ | ZnS | wurtzite | .40 | 0.93 | 20 |
| | ZnO | zincite | .53 | 1.79 | 55 |
| $A^{o}X^{c}_{2}$ | CdCl ₂ | | .54 | 1.47 | 42 |
| $A^oX^h_{2}$ | CdI_2 | | .44 | 0.97 | 21 |
| A ^{cb} X ^{sc} ₂ | CaF ₂ | fluorite | .74 | 2.98 | 89 |