PRINCIPLES OF GEOCHEMISTRY
GEOL 423
PROBLEM SET #4
FALL 2009

PROBLEM ONE:

Determine the percent ionic character of the following bonds, based on their electronegativity differences: a) LiI; b) $NiCl_2$; c) AgCl; d) $GaCl_3$; e) SiC.

PROBLEM TWO:

Using trigonometry, calculate the critical radius ratio for tetrahedral (four-fold) coordination. (hint: the tetrahedral angle formed by two anions and a cation is 109.5°.

PROBLEM THREE:

Determine the coordination numbers of Ca^{2+} and Sr^{2+} relative to O^{2-}, and use the result to predict the substitution of Ca by Sr in calcite (C.N. 6) and aragonite (C.N. 8). That is, in which mineral will Sr be more likely to substitute for Ca? Justify your choice using the radius ratio rule.

PROBLEM FOUR:

Predict whether Cd^{2+} can replace Sr^{2+} in the mineral strontianite ($SrCO_3$). Justify your answer using Goldschmidt's rules.

PROBLEM FIVE:

Silver (Ag^+) is a common trace element in galena where it replaces Pb^{2+}. Identify the ion of a chalcophile (sulfide-loving) element that is best suited to enter galena with Ag^+ in a coupled substitution. Justify your choice using Goldschmidt's rules.

PROBLEM SIX:

For each of the following trace elements found in silicate minerals, name a major element (Si, Al, Na, K, Mg, Ca, Fe, or S) that the trace element commonly replaces in silicate structures: a) Rb^+; b) Sr^{2+}; c) Ga^{3+}; d) Sc^{3+}; e) Li^+; f) Ba^{2+}; g) Ge^{4+}; h) trivalent rare earths (La^{3+} - Lu^{3+}; i) Se^{6+}; j) Ni^{2+}; k) Tl^+ (thallium). Justify your choices using Goldschmidt's rules.

PROBLEM SEVEN:

The mineral chromite ($MgCr_2O_4$) has Mg^{2+} in tetrahedral coordination with oxygen and Cr^{3+} in octahedral coordination with oxygen. Oxygen in turn is surrounded by one Mg^{2+} and three Cr^{3+} ions. Using Pauling's second rule (regarding bond strengths), demonstrate that this results in a stable crystal structure.