Homework 3: Projections in Metamorphic Petrology

Given the following mineral compositions (*Fe is Fe$^{+2}$ unless indicated*):

- Staurolite (St) $\text{(Fe,Mg)}_2\text{Al}_4\text{O}_8[(\text{Si}_3\text{Al})\text{O}_{10}](\text{OH})_2$
- Chloritoid (Ctd) $(\text{Fe,Mg})_2\text{Al}_4\text{O}_2[\text{Si}_2\text{O}_8](\text{OH})_4$
- Anorthite (An) $\text{CaAl}_2\text{Si}_2\text{O}_8$
- GlaucoPhane (Gln) $\text{Na}_2\text{Mg}_3\text{Al}_2[\text{Si}_8\text{O}_{22}](\text{OH})_2$
- Vesuvianite (Ves) $\text{Ca}_{10}(\text{Fe,Mg})_2\text{Al}_4[\text{Si}_2\text{O}_7]_2[\text{SiO}_4]_5(\text{OH})_4$
- Calcite (Cal) $\text{CaCO}_3$
- Epidote (Ep) $\text{Ca}_2\text{Fe}^{+2}\text{Al}_2[\text{Si}_2\text{O}_7][\text{SiO}_4](\text{OH})$
- Kyanite (Ky), $\text{Al}_2\text{SiO}_5$
- Biotite* (Bt) $\text{KFeMg}_2[\text{AlSi}_3\text{O}_{10}](\text{OH})_2$
- Garnet* (Grt) $\text{Fe}_{2.1}\text{Mg}_{0.9}\text{Al}_2[\text{Si}_3\text{O}_{12}]$
- Muscovite (Ms) $\text{KAl}_3[\text{AlSi}_3\text{O}_{10}](\text{OH})_2$
- Cordierite (Crd) $(\text{Fe},\text{Mg})_2\text{Al}_4\text{Si}_3\text{O}_{18}.\text{H}_2\text{O}$
- Diopside (Di) $\text{Ca(Fe,Mg)Si}_2\text{O}_6$
- Grossular (Grs) $\text{Ca}_3\text{Al}_2\text{Si}_3\text{O}_{12}$
- Andalusite (And) $\text{Al}_2\text{SiO}_5$
- Hypersthene (Hy) $(\text{Fe},\text{Mg})\text{SiO}_3$
- Wollastonite (Wo) $\text{CaSiO}_3$

* I picked an intermediate composition rather than one of the end-members.

Show your calculations for all of the following:

1) Calculate and plot St, Ctd, Ves, Cal, An, Gln, and Ep on an ACF diagram. [7 pts]
2) Calculate and plot Ky, Bi, Grt, and Ms on an AKF diagram. [4 pts]
3) Calculate and plot Bt and Grt on an AFM diagram (projected from Mu). [2 pts]
4) You are studying a suite of rocks from a field area. You notice that the rocks contain the following mineral assemblages: [7 pts]
   - And-An-Crd
   - An-Di-Grs
   - Grs-Di-Wo
   - An-Crd-Hy
   - An-Hy-Di

Calculate and plot these assemblages on an ACF diagram (plot the minerals, and connect coexisting phases with tie-lines). What metamorphic facies is represented (see chapter 25)? Why do some rocks have cordierite and others diopside?

(exercise from John Winter, *An Introduction to Igneous and Metamorphic Petrology*, 2001)