1. Fill in the table below by listing the minerals present in each metamorphic zone. Give the name of each mineral and its chemical composition: e.g., Quartz (SiO_2).

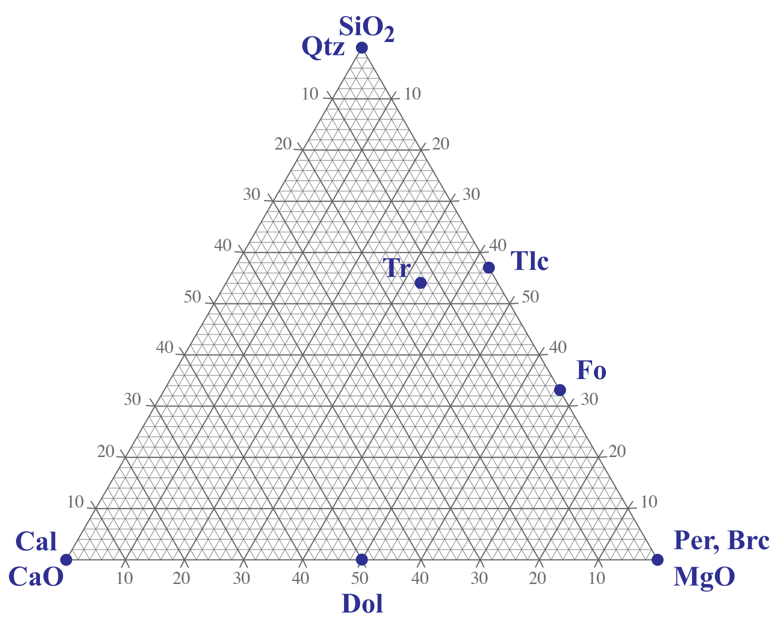
Table 1. Metamorphic mineral assemblages from the Alta stock contact aureole

	Talc Zone	Tremolite Zone	Forsterite Zone	Periclase Zone
1.	**Dolomite** $CaMg(CO_3)_2$	**Dolomite** $CaMg(CO_3)_2$	**Dolomite** $CaMg(CO_3)_2$	**Dolomite** $CaMg(CO_3)_2$
2.	**Calcite** $CaCO_3$	**Calcite** $CaCO_3$	**Calcite** $CaCO_3$	**Calcite** $CaCO_3$
3.	**Talc** $Mg_3Si_4O_{10}(OH)_2$	**Tremolite** $Ca_2Mg_5Si_8O_{22}(OH)_2$	**Forsterite** Mg_2SiO_4	**Periclase** MgO
4.	**Quartz?** SiO_2	**Quartz** SiO_2		**Brucite** $Mg(OH)_2$
5.				**Forsterite** Mg_2SiO_4

2. Which components (use oxides) do you need to define all the minerals on your list?

CaO, MgO, SiO_2, CO_2, H_2O

3. If you eliminate the fluid species, you should be left with three components. On the ternary diagram below, put one component at each corner, and plot the positions of the minerals present in the contact aureole of the Alta stock.



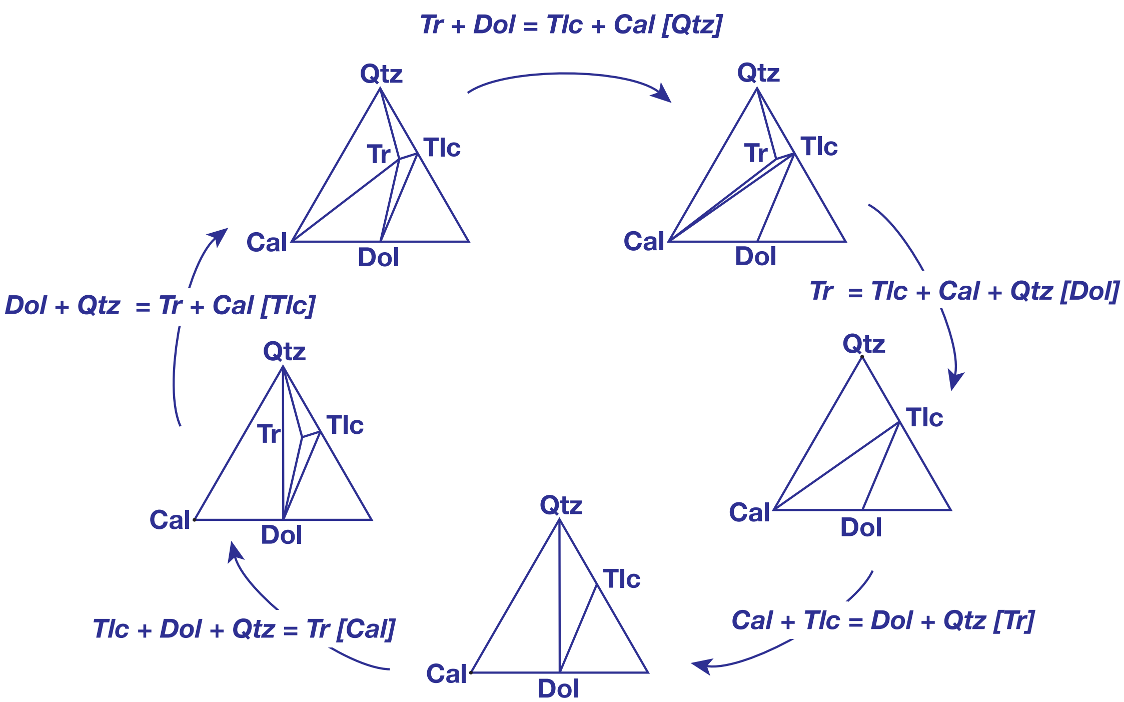
4. Use the phase rule to determine the number of minerals present in these rocks for the following cases. Assume that the fluid species (H_2O and CO_2) are in excess and available.

Invariance: **5**

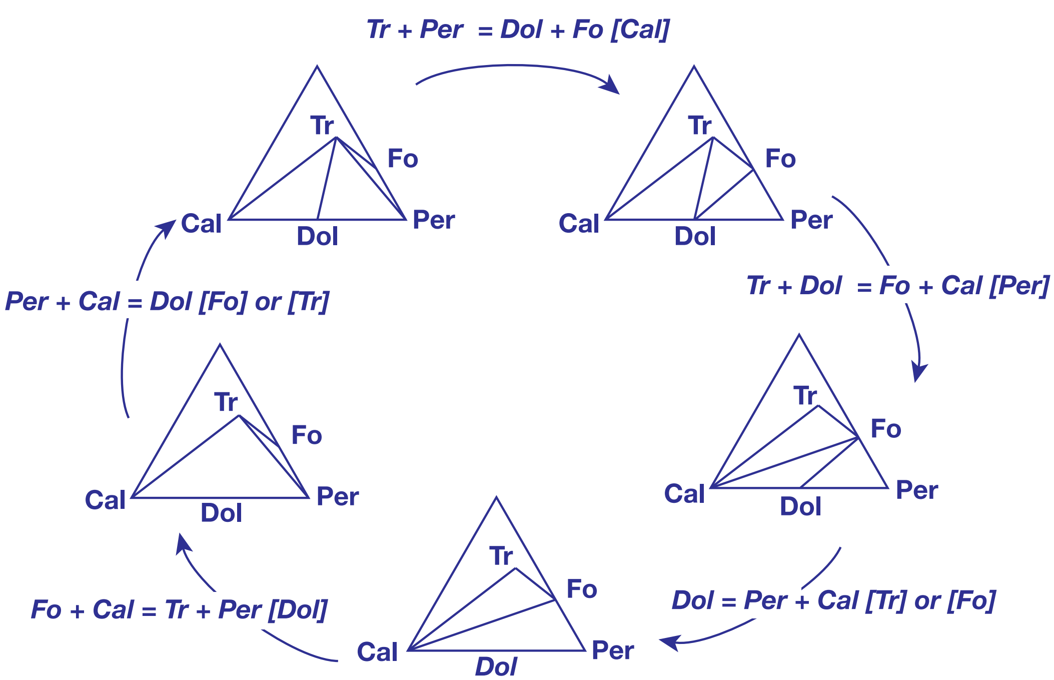
Univariance: **4**

Divariance: **3**

5. Let's work our way up the temperature gradient in the aureole. Construct a chemography (based on what you did in question #3) that can be used to generate reactions to explain the occurrence of the talc and tremolite zones. Mineral coordinates do not need to be precise, but should preserve the important topological relationships between the minerals. On a separate piece of paper, neatly draw the topologies and list the reactions that give you the various topologies in an easy to follow format. Computer generated illustrations are welcome for this question.



6. Repeat question #5 for the forsterite and periclase zones. Note that in these rocks quartz is probably the limiting phase. That is, let's assume that all the quartz was consumed by the reactions you generated in #5.



7. Ultimately we want to plot these reactions on a quantitative T-XCO_2 diagram so that we can constrain the temperature and fluid composition in the contact aureole. Now that you have the topologies and reactions, draw the Schreinemaker's bundles in T-XCO_2 space for #5 and #6. For #5, draw the bundle assuming that 1) Dol + Qtz is on the low temperature side of the reaction, 2) Tr + Cal is favored at high XCO_2, and 3) Tr + Dol is favored at low XCO_2. For #6, draw the bundle using your own geologic intuition. Use the space provided below with the y-axes =T and the x-axis = XCO_2.