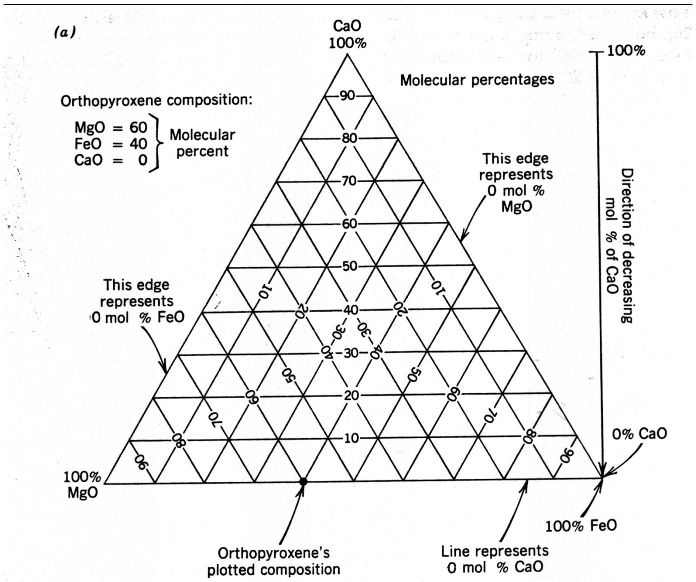
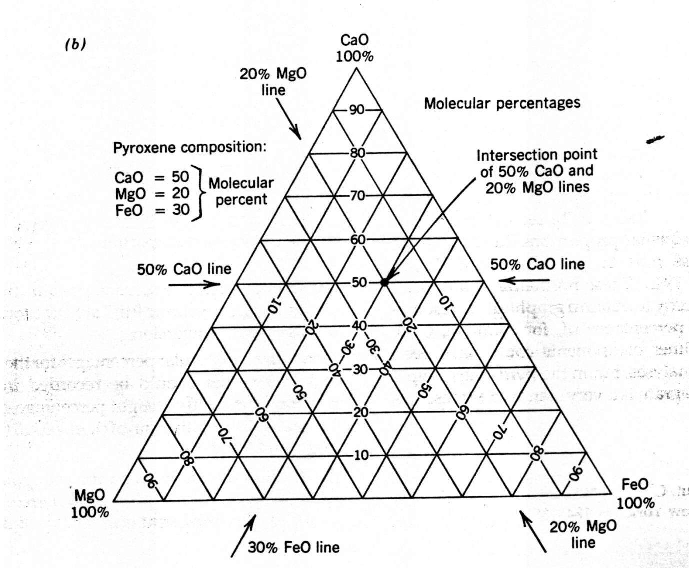
EAS 31113/B9019: Sedimentology
Review of Ternary Diagrams





Ternary diagrams illustrate the independent variation of (at least) three components graphically. This type of plot is used in many applications, for example, to show the extent of chemical substitution of selected components in mineral groups that show solid solution. In sedimentology and soil science they are used to classify rock or soil samples. The ternary diagram on the left has tick marks every 10%.

Example: Pyroxene is a major mineral component of basalts. In the pyroxene group major chemical variations are shown by CaO, FeO and MgO (in molecular percentages) – or in the equivalent Ca, Fe, and Mg components (in atomic percentages). We also may instead choose FeO, MgO and Al_2O_3, or CaO, FeO, and MnO. The choice of components depends on the information you are trying to obtain from the plot.

There are particular conventions that are used in triangular plots. In the case of a feldspar system where the components are CaO, K_2O, and Na_2O, usually the top corner is assigned to K_2O, the lower left corner to Na_2O, and the lower right to CaO. For the pyroxenes the upper corner is generally assigned to CaO, the lower left to MgO and the lower right to FeO.

In the Pettijohn classification of sandstones, the main mineral components are quartz, feldspar and lithic fragments with smaller proportions of lithic fragments and feldspar in finer-grained rocks as expected from maturation of clasts. Conventionally, quartz is the top component, feldspar is the left corner and lithic fragments are on the right corner.

How To Plot Percentages

To plot a composition all three components must be present in the material. Notice in the figure above how the corners have 100% notations; the diagram also shows percentage graduations, identified by numbers such as 90, 80, 70, and so on, along the lines parallel to the edges of the triangle and away from the corners. These lines define directions in terms of the decreasing percentage of the corner component. This means that an analysis with 50% molecular CaO plots on the horizontal line marked 50%. The location of the composition we want to plot (where exactly along the horizontal line) will be defined after we plot the MgO (or FeO) value of the analysis. Thus, in a three component system the third component value is not necessary for the location of a graphical position but it is useful as a verification of the accuracy of the plotted point.

<u>What type of data are we looking at?</u>
Chemical analyses are typically given in weight percentage values. Mode, or mineralogical proportions in a rock is given in volume percent (vol %). We can plot the percentage values of the three components after normalizing to 100%.
Mineralogists and petrologists find it useful to plot molecular or atomic percentages that can be derived from a weight percent analysis. This is can be accomplished by dividing the weight percentage values by the molecular weights. Second, the values obtained for the molecular proportions are then normalized to 100%.
For modal analyses, the relevant components are normalized by dividing each component by the total of species comprising the corner end-members and multiplying by 100%. These normalized values can now be plotted directly to obtain a graphical representation.

<u>Assignment</u>
Create a Pettijohn plot using the data below. The table lists modal analyses for 5 sandstones. Assume these are all medium to coarse-grained rocks. Reproduce the table and make calculations in Excel.

1. For each analysis select the volume percentage values for quartz, feldspar and lithic fragments and normalize with respect to the three components. This is done by take the three values, adding them and dividing each component by the sum. Record them in the space provided (below the weight percent columns. Clearly, the sum of these sets of three values **must** total 100%.
2. Plot each analysis on the blank triangular plot provided by finding each normalized component, drawing a line in pencil and plotting a point where the three lines intersect. Make sure you label the point with the corresponding sample number.
3. At the bottom of the normalized table write down what type of sandstone each sample is according to the Pettijohn classification.

	Volume Percent Values				
	1	**2**	**3**	**4**	**5**
Quartz	90	55.94	10	6	42.48
Lithic fragments	1	3.12	54.11	1.35	37
Na-feldspar	0.38	7.15	15.73	22.65	3
magnetite	1	0.19	0.34	0	0.76
K-feldspar	3	32.12	18.66	60	15
Other	4.62	1.48	1.16	10	1.76
Total					

	Normalized Percent Values				
	1	**2**	**3**	**4**	**5**
Quartz					
Total Feldspar					
Lithic fragments					
Total					
Type of Sandstone					

4. If you're feeling ambitious, replot all of these analyses using an excel macro called Tri-plot, which can be downloaded from the course Blackboard page or at the following URL: http://www.lboro.ac.uk/research/phys-geog/tri-plot/index.html.