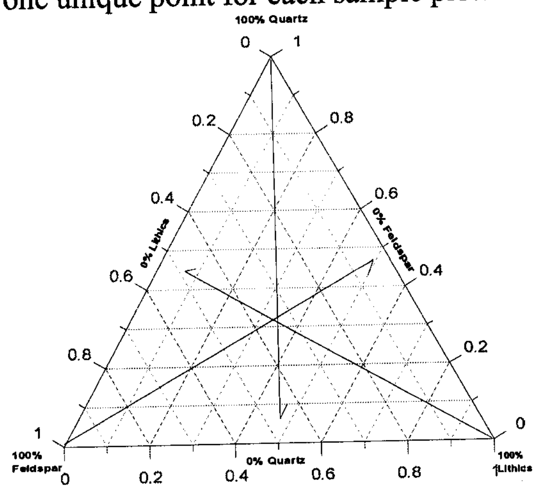
G302 – Class Exercise
Application of Ternary Diagrams to Geologic Problems

Introduction

Triangular or ternary diagrams are useful for scientific analysis of 3 end-member systems. Triangular diagrams are used in soils classifications, petrographic analysis, and any other scientific endeavor that involves three mutually-dependent components. Examples of three end-member systems include percent sand-silt-clay in soil samples, percent quartz-feldspar-lithic fragments in sandstone samples, and alkali-iron-magnesium content in a volcanic rock.

Methodology

Creating triangular diagrams involves the following steps: (1) collect raw data for three end-member systems in the form of mass, weight, or numbers of occurrences (frequency), (2) re-normalize the raw data to percent of total occurrence, i.e. the three components per sample are summed, and the percent of each of the three end-members is calculated for each sample., (3) plot the three end members on ternary diagrams. 100% of each component is represented by the apex of the angles at the respective positions, 0% of the component is represented by the leg opposite the angle. If the total percent of the three components add up to 100%, there is one unique point for each sample plotted on the diagram.



Exercise

Part 1 - Table 1 shows raw point count data for sandstone samples collected in the eastern Cascades of Washington. Point count data is collected by counting the number of occurrences of mineral types in sandstones, as viewed under a microscope. Three components were identified in the sandstones, Quart, Feldspar, and Lithic (rock) fragments (i.e. Q, F, L). Renormalize the raw pointcount data to percentage, fill in the remainder of table 1, and plot (by hand) the QFL position of each sample on Figure 1 – QFL triangular diagram after Dickinson and Suczek (1979). Using the classification scheme on the diagram, write a brief summary of the results, indicating whether the sandstone sediments were derived from continental crust, a volcanic arc, or a collisional tectonic belt.

Part 2 – Using excel and grapher, enter the data from Table 1 and create the same triangular plot using grapher software. Label all parts of the graph, including the sandstone-type classification, put your name on it, and print.

Part 3 – Using excel and grapher, complete question 6.4 on p. 97 of the Waltham Text. Follow the directions in the question, but instead of plotting the data on Fig. 6.8 of the text, plot it using grapher. Label all graph axes, and include your name, print the results.

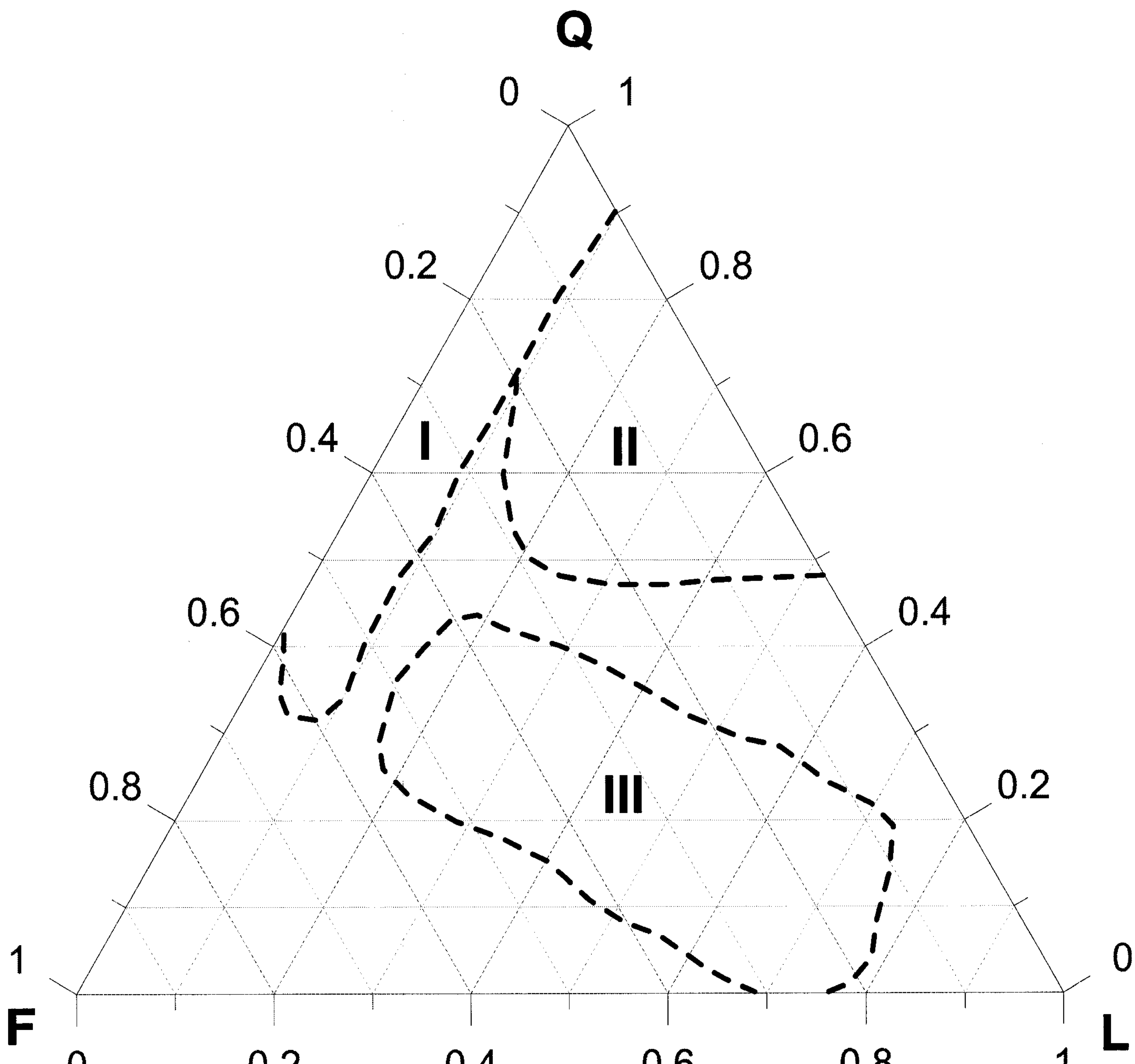
Table 1 - Swauk Formation Sandstone Petrographic Data

Point Count Data							
No. of Quartz	No. of Feldspar	No. of Lithic Fragments	Sum Q-F-L Counts	Quartz%	Feldspar%	Lithics%	Sample No.
81	63	6					83-24
72	73	4					83-26
45	96	9					83-27
45	76	29					83-33
53	76	21					83-34
72	76	2					83-1
42	101	7					83-4
54	81	15					83-8
42	96	12					83-9
56	70	24					83-10
65	75	10					83-17
51	90	9					83-23
52	93	5					83-20
42	101	7					83-21
50	88	12					83-22
76	72	2					83-37
72	72	6					83-40

Figure 1 - Sandstone Provenance Fields from Dickinson and Suczek (1979)

Sandstone Types

I - Sediments Derived from Continental Crust
II - Sediments Derived from Volcanic Arc
III - Sediments Derived from Collisional Tectonic Belts



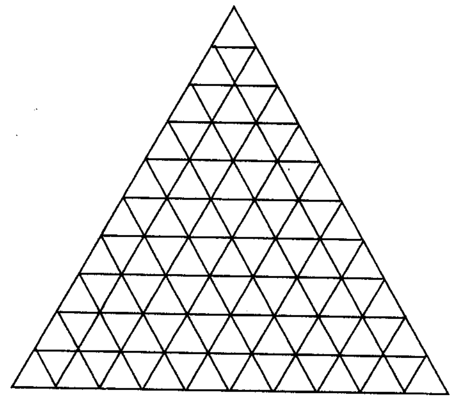


Fig. 6.8 A triangular diagram net. Lines are drawn here at 10% increments although most such graph paper would also have 1% intervals marked.

is done. In Fig. 6.7a, a line has been drawn which connects the 40% clay, 60% sand point to a point representing 40% clay, 60% silt. All points along this line contain 40% clay but have differing amounts of sand and silt making up the remaining 60%. Similarly, Fig. 6.7b shows a line representing all points which have 36% sand. The point where the 40% clay line intersects the 36% sand line is, of course, a point representing a sediment with 36% sand and 40% clay and which must, therefore, be 24% silt.

To assist in accurate plotting of such points, a triangular net similar to that shown in Fig. 6.8 is used. For clarity in this illustration, the lines are drawn at 10% intervals, although these lines will usually be plotted at 1% intervals on most sheets of triangular graph paper.

Question 6.4 Use Fig. 6.8 or some triangular graph paper to plot an AFM diagram as follows.

The left corner of the plot represents 100% ($Na_2O + K_2O$). The right-hand corner represents 100% MgO. The top corner represents 100% ($FeO + Fe_2O_3$). Mark these points on your graph and then plot the following data which is taken from a set of related volcanic rocks.

(i) 10% ($Na_2O + K_2O$), 45% MgO, 45% ($FeO + Fe_2O_3$).
(ii) 10% ($Na_2O + K_2O$), 35% MgO, 55% ($FeO + Fe_2O_3$).
(iii) 10% ($Na_2O + K_2O$), 25% MgO, 65% ($FeO + Fe_2O_3$).
(iv) 12% ($Na_2O + K_2O$), 20% MgO, 68% ($FeO + Fe_2O_3$).
(v) 15% ($Na_2O + K_2O$), 15% MgO, 70% ($FeO + Fe_2O_3$).
(vi) 18% ($Na_2O + K_2O$), 12% MgO, 70% ($FeO + Fe_2O_3$).
(vii) 23% ($Na_2O + K_2O$), 12% MgO, 65% ($FeO + Fe_2O_3$).

A graph such as this can furnish significant information about the evolution of a volcanic rock series. However, the way in which this is done, as well as the details of how to obtain the numbers to plot, is beyond the scope of this book.