Appendix Interpreting Ternary Diagrams

Ternary (triangular) diagrams are used to determine the composition of igneous rocks on the basis of the abundances of end members. As an example, consider the classification of an igneous rock composed of 40% quartz, 20% pyroxene, 10% alkali feldspar, and 30% plagioclase feldspar. As classification using ternary diagrams is based on the abundances of only three end members, we are concerned only with the relative abundances of the end members of interest and not with the abundances of any other components.

For plutonic rocks, using Figure 2.1a in this *Assignment Manual* as an example, the end members of interest for our particular sample are quartz, alkali feldspar, and plagioclase; the pyroxene is not of interest in this classification scheme. Consequently, the abundances of the end members of interest must be "normalized" to 100% before we can use the ternary diagram. Normalization is accomplished by dividing the abundances of each of the three end members by the sum of the abundances of the three end members, as indicated below.

Total abundance of the three end members of interest:

  40% (quartz)
+ 10% (alkali feldspar)
+ <u>30%</u> (plagioclase)
  80%

Normalized abundances of the end members of interest:

$$\text{quartz} = \frac{40\%}{80\%} \times 100 = 50.0\%$$

$$\text{alkali feldspar} = \frac{10\%}{80\%} \times 100 = 12.5\%$$

$$\text{plagioclase} = \frac{30\%}{80\%} \times 100 = 37.5\%$$

$$\text{total} = 100\%$$

Once we have determined the normalized abundances, we can plot them on a ternary diagram and determine the rock's name. A normal ternary diagram consists of a grid of lines running in three directions as shown in Figure A.1, below.

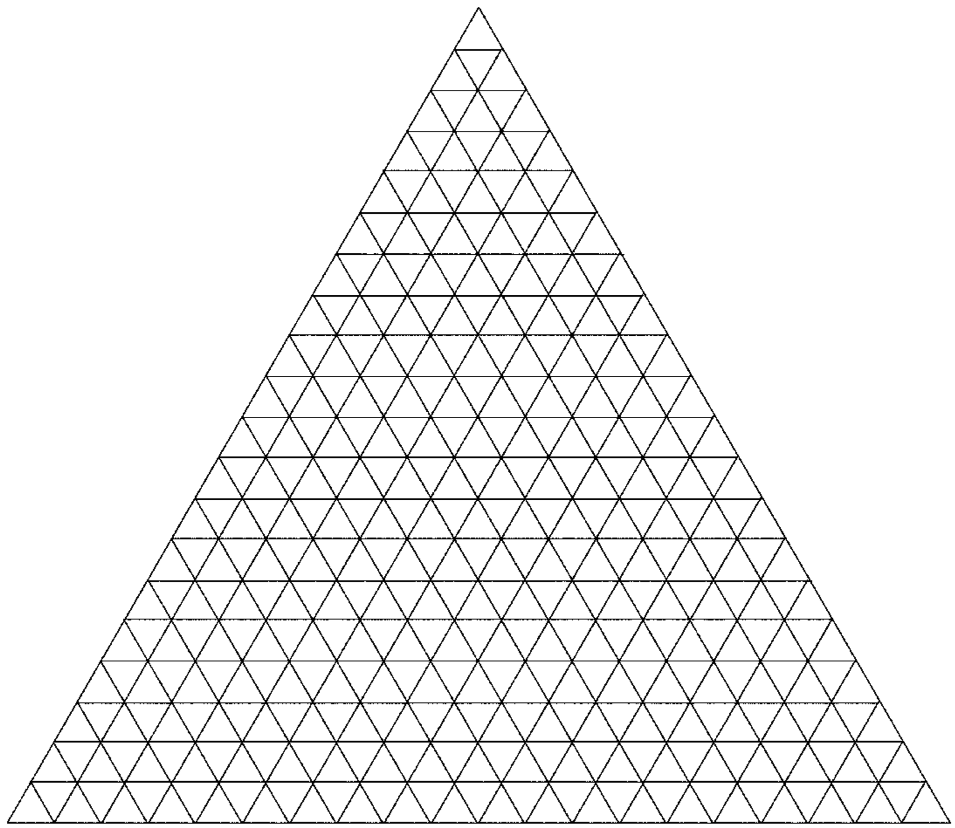

Figure A.1. A ternary diagram with superimposed grid lines.

Only two of the three normalized abundances are needed to define a point on a ternary diagram. The abundance of any one component will define a line, so that two components (two lines) will define a point of intersection.

On a ternary diagram, the abundance of each end member plots as a line parallel to the base opposite the vertex labelled with the name of the end member. For example, the lines corresponding to various abundances of quartz are shown in Figure A.2, below.

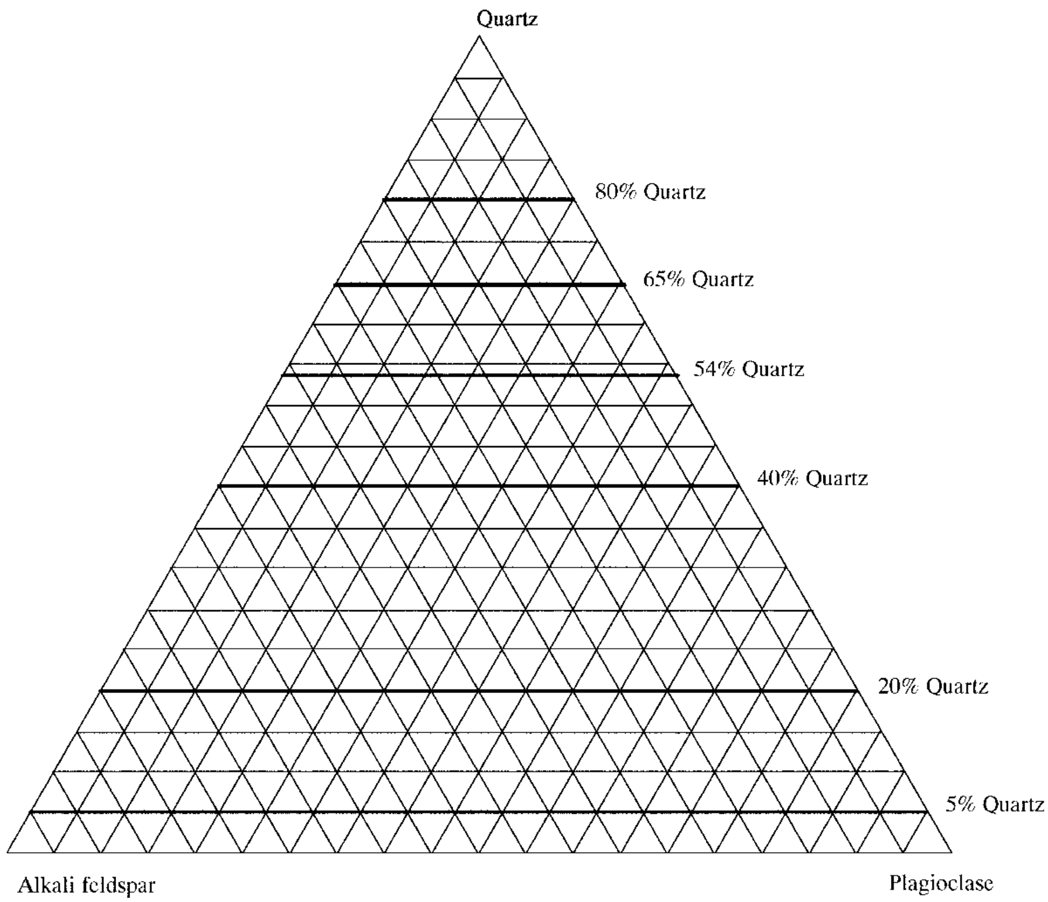

Figure A.2. Lines representing various abundances of quartz.

When you plot the abundance of each end member, the vertex of the end member of interest must face away from you. For our particular example, you would first plot the abundance of quartz (50%). You would do so by orienting the ternary diagram so that the quartz vertex faces away from you, counting up from the baseline (the side closest to you) to 50% and drawing a line at this abundance (remember that any abundance line is parallel to the baseline for that end member). This line is shown in Figure A.3, below.

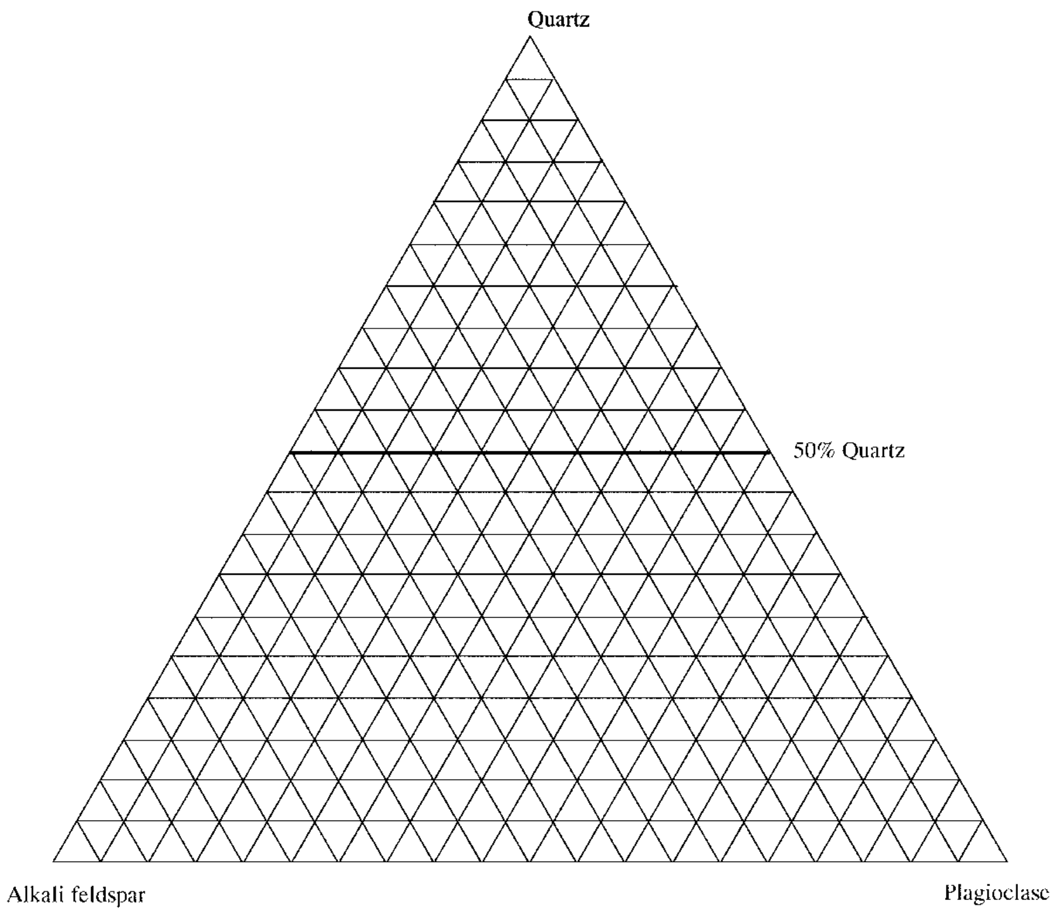

Figure A.3. Line representing 50% quartz abundance.

Once you have plotted the line for the quartz end member, you can proceed to plot another end member (the order or choice of end members is not important). Suppose you choose the alkali feldspar end member. You know from the normalized abundances above that the rock contains 12.5% alkali feldspar. To plot this value on the ternary diagram, you would rotate the figure until the alkali feldspar vertex faces away from you (see Figure A.4, below), count up 12.5% from the baseline closest to you, and draw a line parallel to the baseline at this abundance. As you see, the intersection of these two lines defines a point; consequently, it is not necessary to plot the abundance of the third end member (plagioclase in this case).

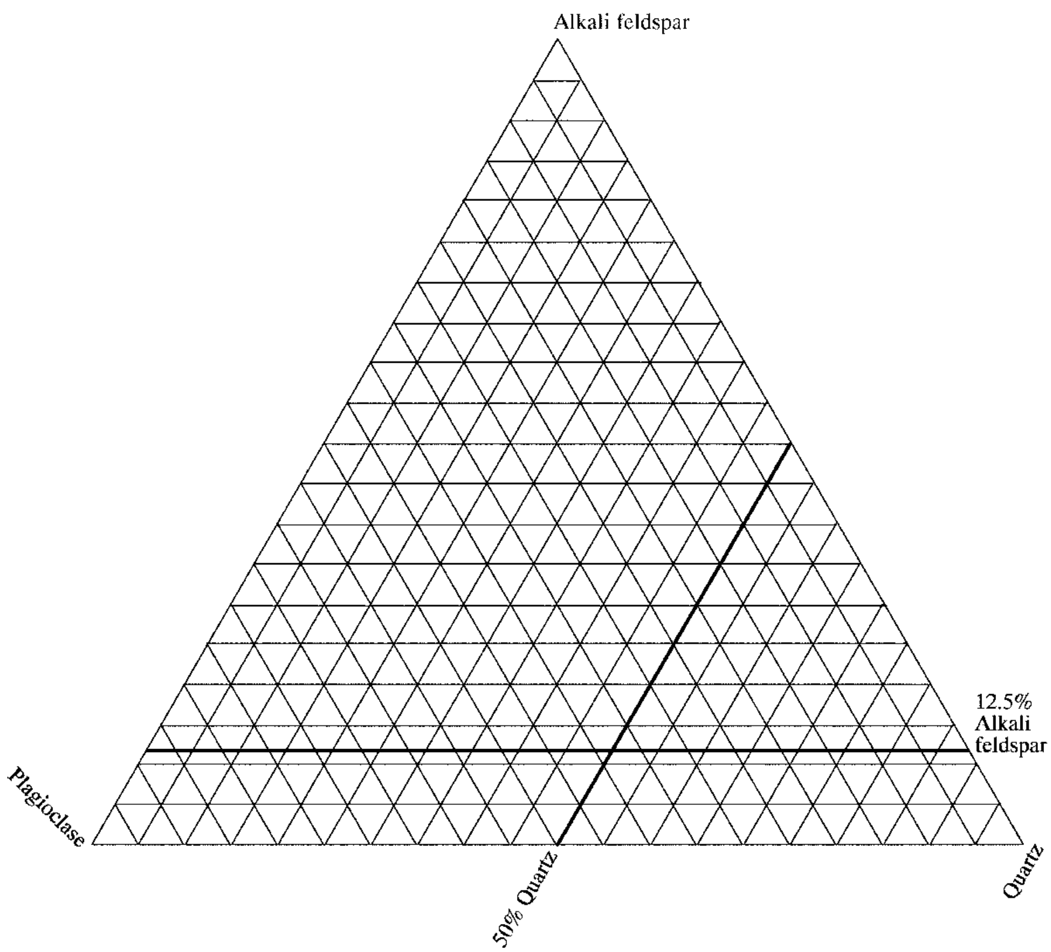

Figure A.4. Line representing 12.5% alkali feldspar abundance.

Although the plots of two of the end members do define a point, plotting the third end member is often a good idea; if it does not intersect at the same point as the other two lines, you know that either the normalization or the plotting has been done incorrectly.

This third line is plotted in the same way as the other two. Rotate the ternary diagram until the plagioclase feldspar vertex points away from you, count up from the plagioclase baseline (the baseline closest to you) until you reach its normalized abundance (37.5%), and draw a line at this point parallel to the baseline (Figure A.5, below). If your methodology was correct, the three lines should intersect at a common point.

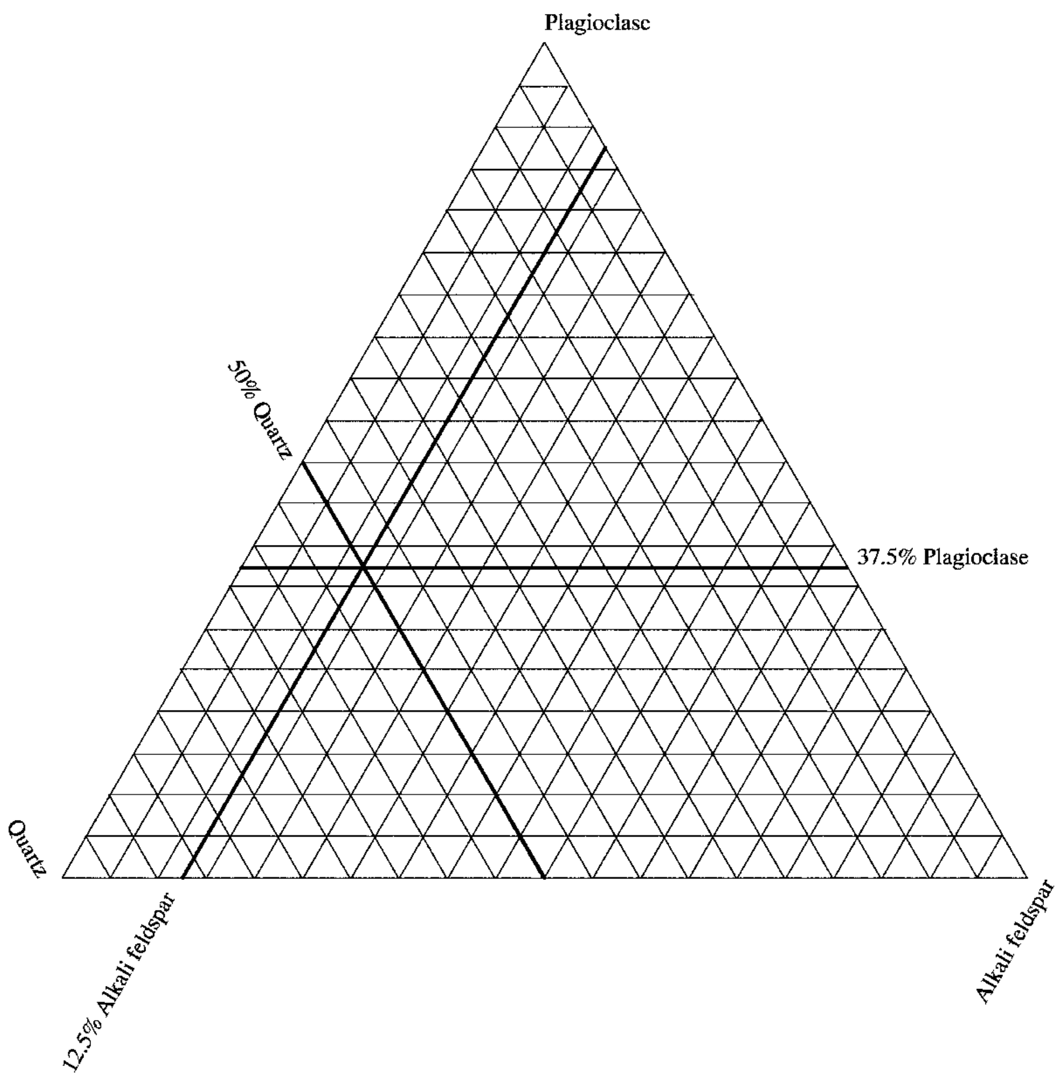

Figure A.5. Line representing 37.5% plagioclase abundance.

The common intersection point can then be translated to the ternary diagram for plutonic rocks. The rock name is determined by the field in which the point of intersection lies (grano-diorite in this case; see Figure A.6, below). Note that this procedure could have been carried out directly on the plutonic rock ternary diagram, although not all of the contour lines are provided on this figure.

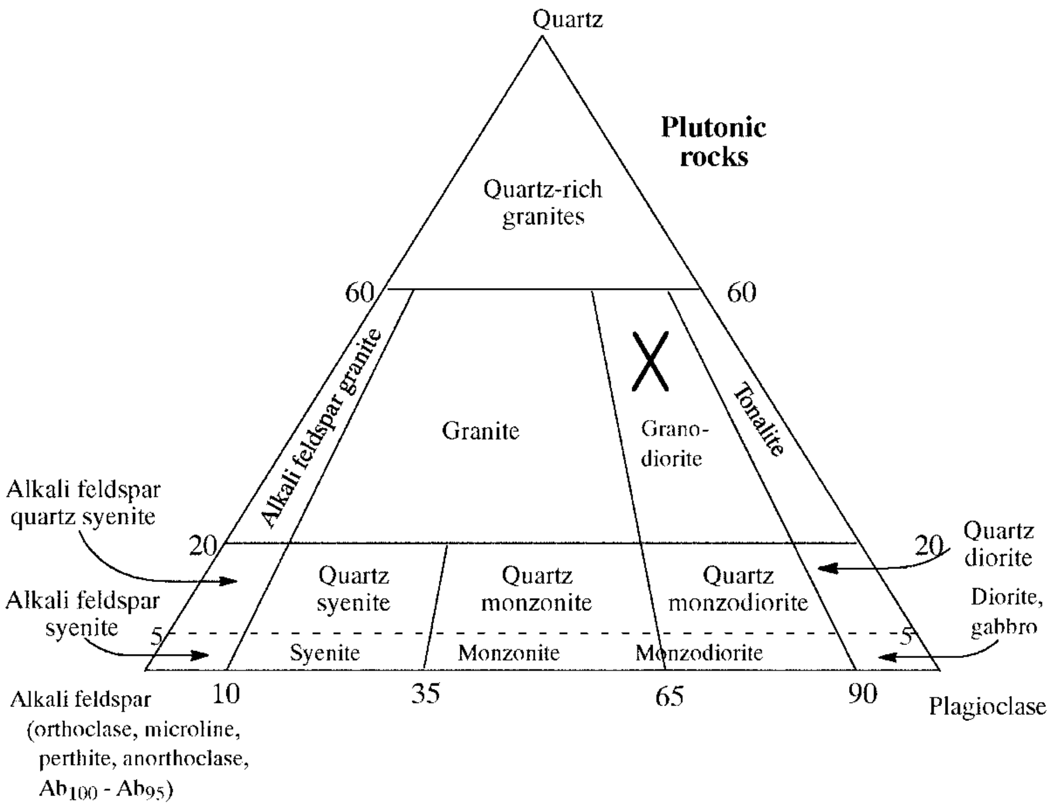

Figure A.6. Use of an intersection point to determine a rock name.

If one were to attempt to plot the unnormalized abundances of quartz, alkali feldspar, and plagioclase for our particular sample on a ternary diagram, the three abundance lines would not intersect at a point (see Figure A.7). This fact would immediately indicate that your methodology was incorrect.

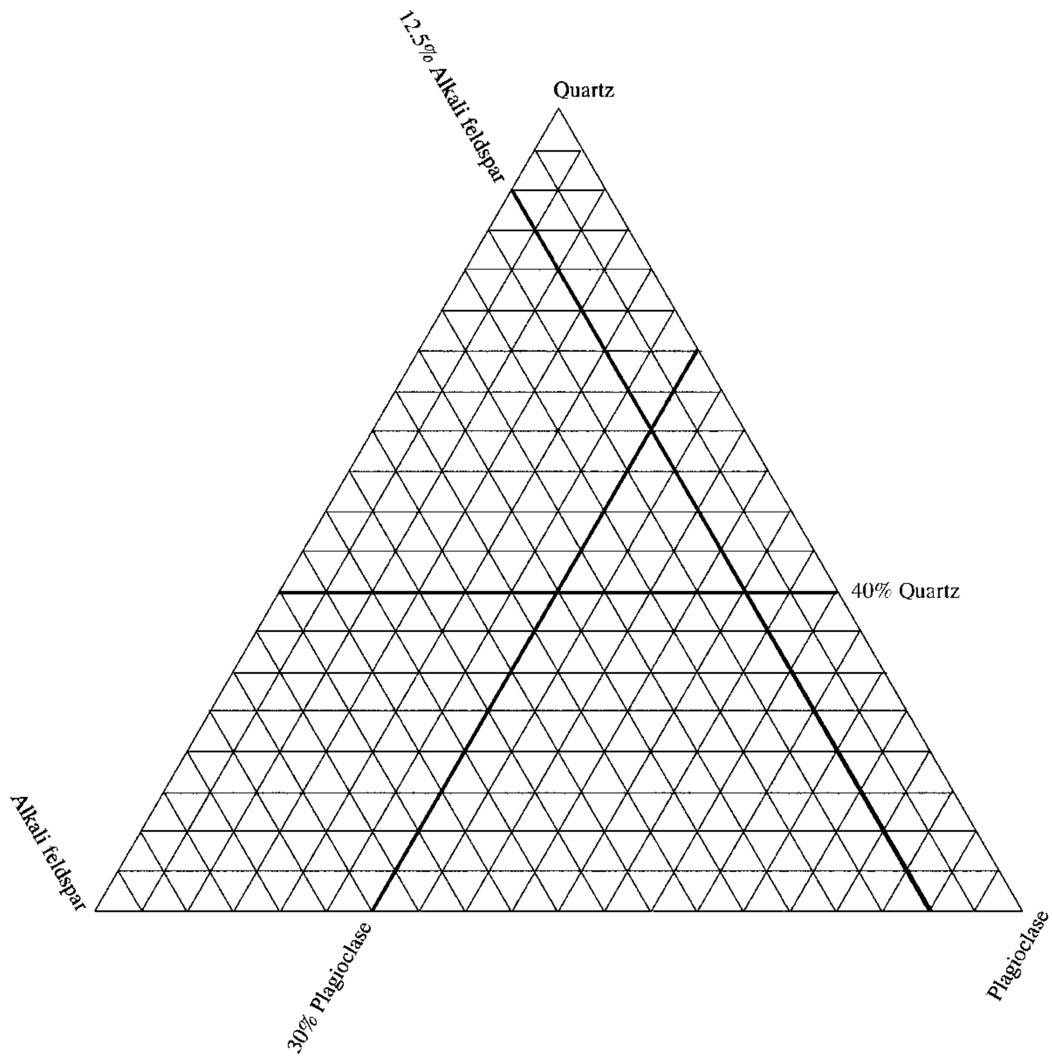

Figure A.7. Plot of unnormalized abundances of quartz (40%), alkali feldspar (10%), and plagioclase (30%).