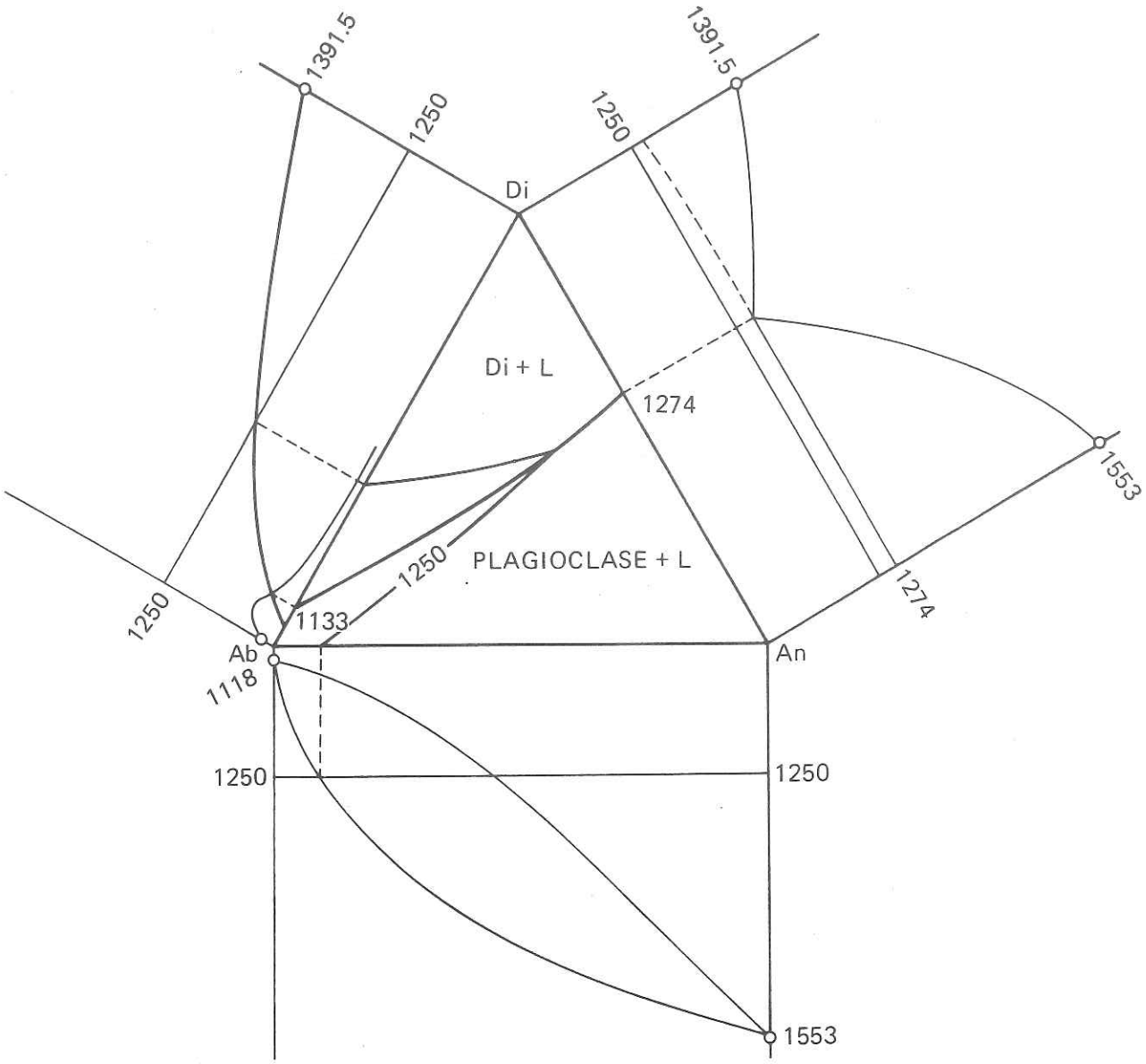
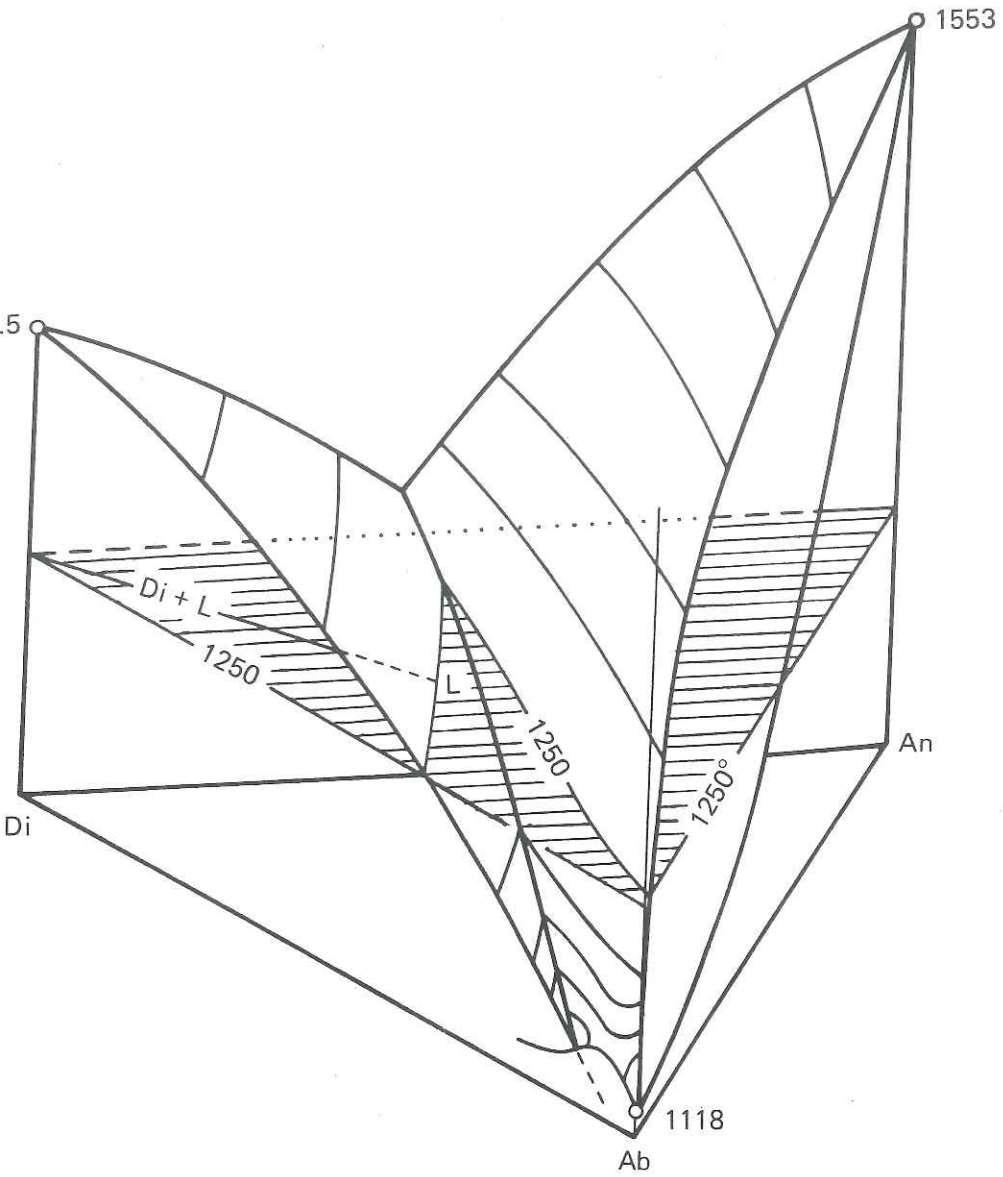


Figure 8.2. Deduction of the ternary *X-X* plot of Di-An-Ab from the three boundin *T-X* binaries. The central triangle is the *X-X* plot, and the *T-X* plots, joined to th triangle at the 1100°C isotherms, may be considered folded-down walls of a *T-X* prism of which the triangle is the base.

then must be connected by a univariant line running through the triangle There is no reason for such a line to be straight, so we shall draw it curved it is the heavy line in the triangular part of Fig. 8.2.

There is no liquidus intersection for An-Ab. The resulting ternar diagram is very simple. There appear to be two primary fields, one in whic Di appears first on the liquidus, and another in which Plag. appears first o the liquidus. These primary phase fields are exactly analogous to thei binary counterparts in Di-An and Di-Ab. The line separating the two field is a field boundary (or cotectic), supposedly also a univariant line. This lin slopes in temperature from 1274° at Di-An to 1133° at Di-Ab. It is like stream on a topographic map. To summarize thermal information about th

nmarize the geometry of our deduced system Di-An-Ab, a per-
drawing (Figure 8.3) is useful. The temperature axis is vertical, so
lete model is a triangular prism arising from the *X-X* base. The
ndary and the 1250° isothermal plane are shown in the drawing,



Perspective drawing of the ternary *T-X* prism Di-An-Ab-*T*. The two liquidus surfaces are shown ruled with temperature contours. An plane (1250°C) is shaded.

of the field boundary must be located by experiment, and the compositions of plagioclase solid solutions in equilibrium with a given liquid must be determined experimentally. The experimentally determined phase diagram, modified slightly from that of Bowen (1915), is shown as Figure 8.4.

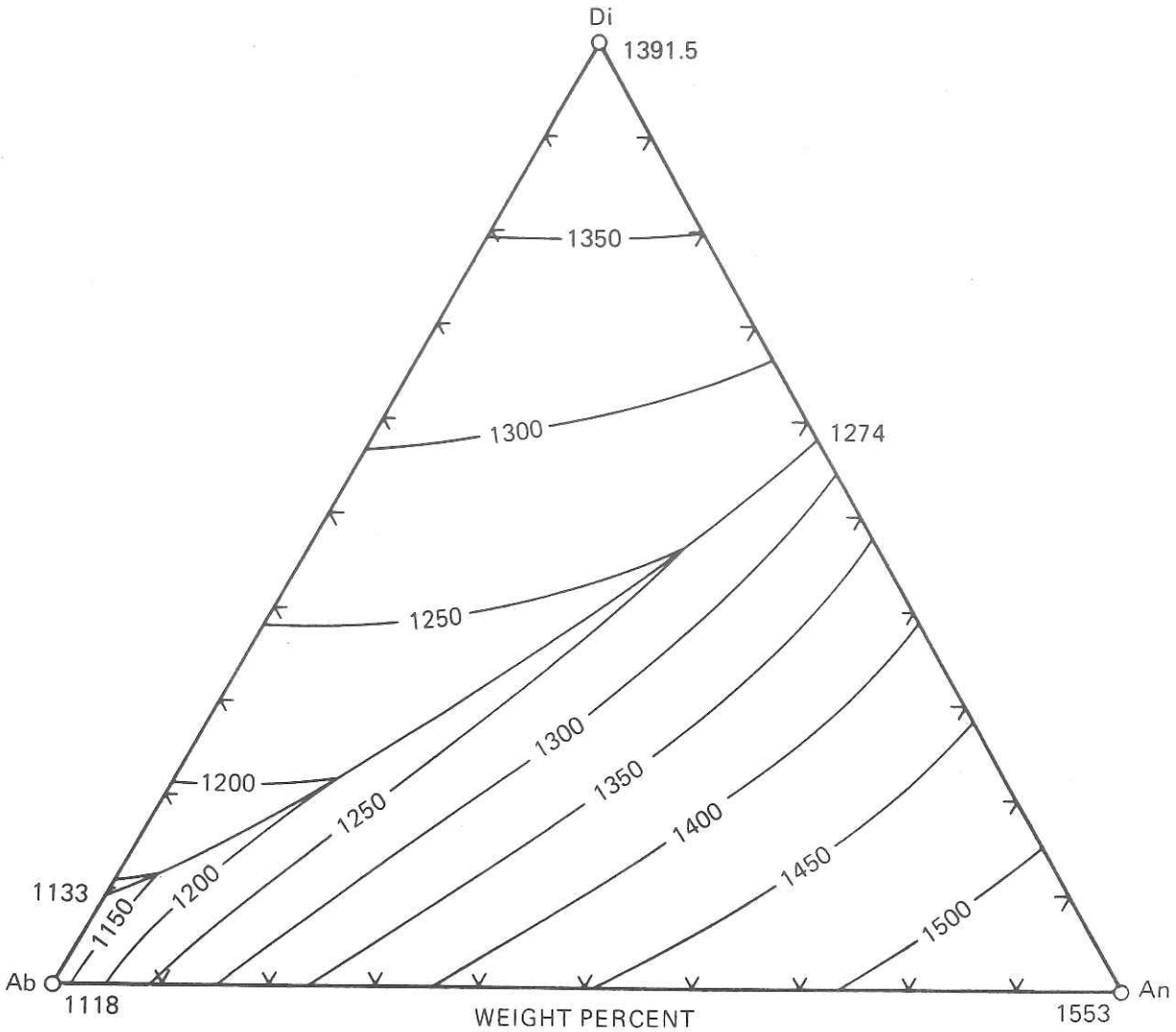


Figure 8.4. Phase diagram, after Bowen, of the system Di-An-Ab. The Di-Ab sideline is revised after Schairer and Yoder (1960) and the Di-An sideline after Osborn and Tait (1952). See also Kushiro (1973). Base of diagram measures 10 cm.

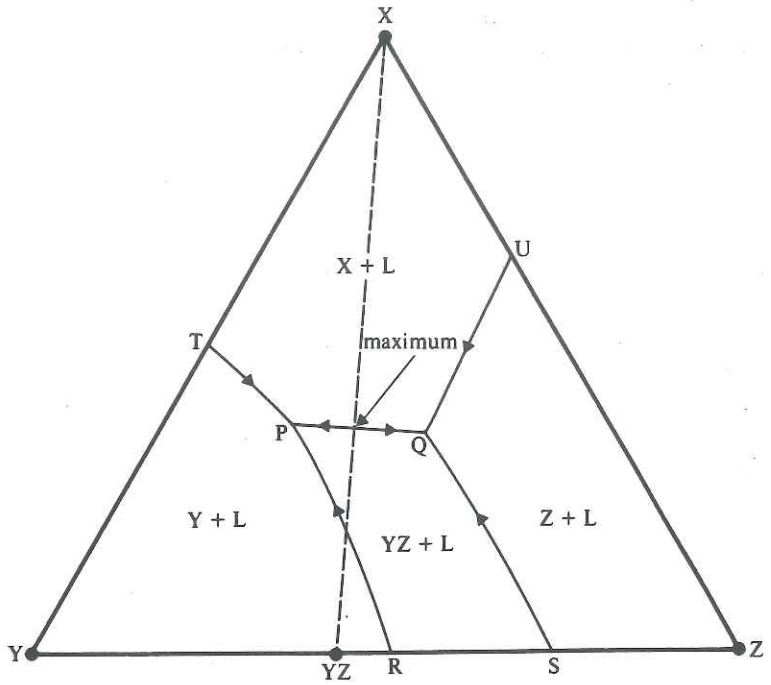


Figure 4.7 Ternary system with an intermediate compound showing incongruent melting. Directions of falling temperature in divariant equilibria are shown by arrows. Broken line is the stable sub-solidus join X–YZ.

example which has a thermal maximum on it, which results from the fact that the boundary curve crosses its own join, X–YZ. It therefore has two temperature arrows pointing in opposite directions.

Isothermal sections. The nature of different types of divariant equilibria is best investigated by the isothermal section method. Figure 4.8 shows a partial isothermal section of a ternary for a boundary curve such as QU in Figure 4.7. The section contains a triangular area where all charges consist of X + Z + L at a temperature of 1000 °C. This is flanked on either side by areas of X + L and Z + L which are themselves limited by the 1000 °C isothermal contour where they come into contact with the L field. L_1 is the special liquid at 1000 °C which equilibrates with both X and Z, and lies on the boundary curve QU, shown as a broken line. A composition *a* which lies within the X + Z + L field crystallises X at a temperature above 1000 °C and its residual liquid evolves to meet the boundary curve at L_2. Subsequent cooling sees the

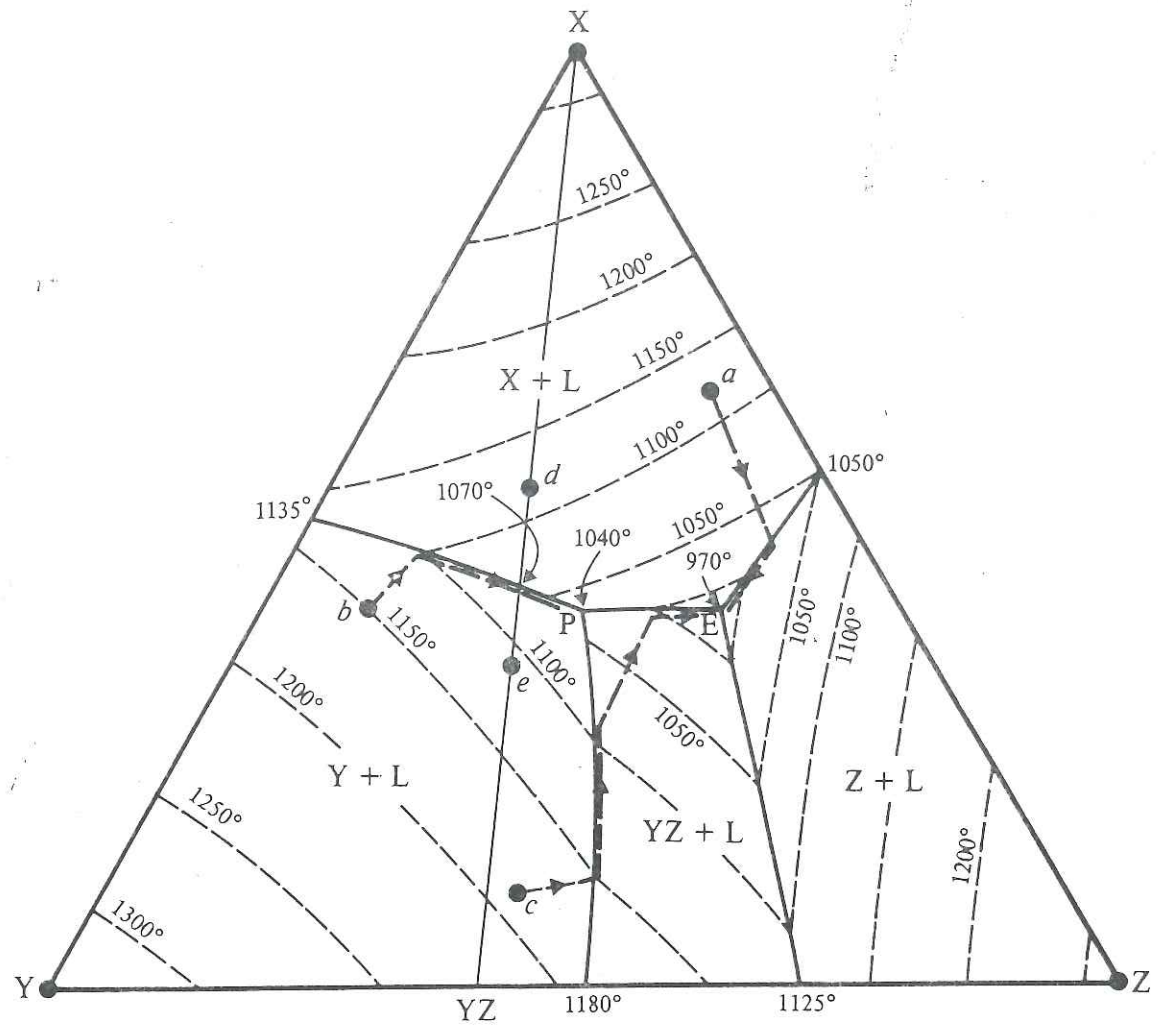


Figure 4.14 Equilibrium crystallisation paths in a hypothetical ternary system X–Y–Z.

and melting paths. An intermediate compound YZ has composition $Y_{60}Z_{40}$ in weight per cent. Preliminary examination of the diagram shows the following features:

(a) The intermediate compound YZ melts incongruently to a Z-rich liquid at 1180 °C. All the other binary reactions are eutectic.
(b) The divariant equilibria are all co-precipitational except for the equilibrium Y + YZ + L which is resorptional down-temperature for Y. (In referring to equilibria, as opposed to reactions, the + sign is used only to signify 'in equilibrium with'.)
(c) One of the univariant equilibria (X + Y + YZ + L at 1040 °C) is resorptional down-temperature (for Y). The other, X + YZ + Z + L is co-precipitational at 970 °C (liquid E).
(d) Considering the three bulk compositions *a*, *b* and *c* it is clear that *a* and *c*, since they lie inside the sub-solidus triangle X–YZ–Z, must crystallise eventually to this assemblage and their final liquid must be E. Conversely *b* crystallises to the assemblage X + Y + YZ, the final liquid being P.

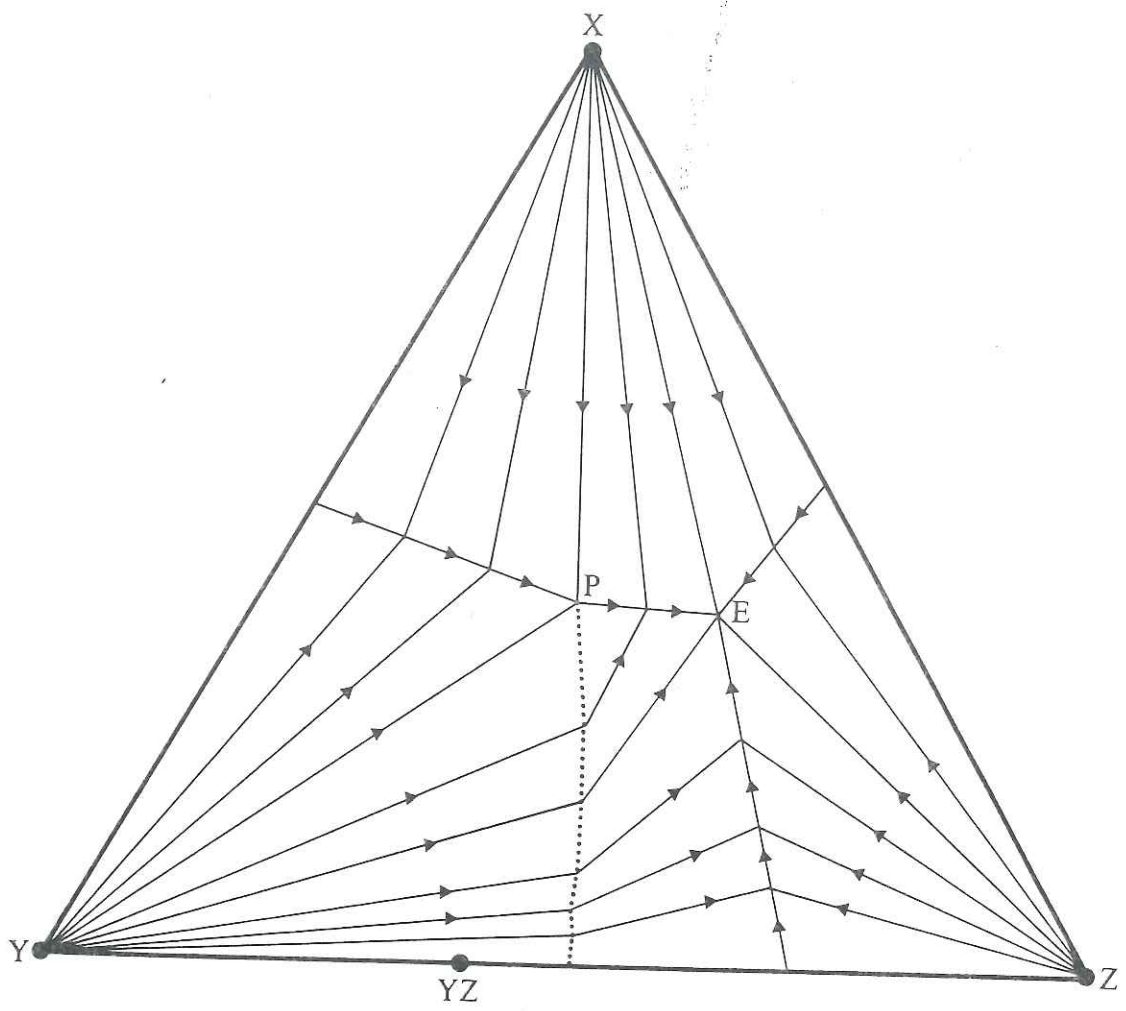


Figure 4.17 Liquid paths of fractional crystallisation in the system illustrated in Figures 4.14–4.16.

on Mull + Cord + L at *d* where the extension of the Mull–Cord join crosses the boundary curve. Inspection of Figure 4.10 shows that all liquids lying on the silica-rich side of the join must ultimately fractionate to the Tr + En + Cord eutectic whereas those on the silica-poor side will eventually fractionate towards Fo + En + Cord.

A special fractionation path *ae* across the sapphirine field is the route taken by *all* liquids which have previously reached the co-precipitational Mull + Sp + L boundary by earlier fractionation of spinel, corundum, and mullite.

Pseudobinary systems

The join X–YZ in the system illustrated in Figures 4.14–4.17 is an example of a pseudobinary system. If mixtures of X and Y were made up and their phase relations presented as a $T-X$ diagram the result would be as shown in Figure 4.19 which is constructed from Figure 4.14