

4.7. pH variation

In natural systems the principal agent responsible for changes in pH must be carbon dioxide; changes in its concentration will affect relative solubilities of silicates and hence the position of phase boundaries. Experiments designed to test this effect will be discussed later. An increase in alkalinity accelerates the formation of quartz from amorphous silica so that variation in silica activity is a complicating factor.

The significance of pH variation on high level occurrences of calcite-laumontite veins and of laumontite replacement of shell material in fossils is a matter for future investigations.

4.8. Water content

The total zeolitization of a feldspathic rock requires a large quantity of water (around 10 per cent) and in many cases this may not be available. Thus in many regions subjected to the P - T conditions of the zeolite facies alteration may be incipient only. This in no way invalidates the recognition of zeolite facies conditions. Boundaries between hydrates will occur at the same temperatures and pressures as in a system with sufficient water, allowing of course, for possible osmotic conditions. Thus, as far as thermal history is concerned, traces of zeolitization as in some rocks of the Alpine Facies of New Zealand will be just as significant as complete alteration. In the partially altered Taringatura rocks the assemblage heulandite + detrital plagioclase does not represent equilibrium. Nevertheless the heulandite is followed by laumontite, and laumontite by still less hydrous phases. Providing successive dehydration transitions such as heulandite \rightarrow laumontite are observed with increasing temperature it may be inferred that P_{H_2O} has been fixed by external conditions, notably depth, and the reasons for persistence of relict plagioclase (or other water-poor phases) are either kinetic or the result of lack of access by water to grain boundaries. Such conditions are not those of true water deficiency. On the other hand some high-level occurrences of laumontite could be due to water deficiency.

4.9. Phase rule relationships

At equilibrium in either the system $Na_2O \cdot Al_2O_3 - SiO_2 - H_2O$ or $CaO \cdot Al_2O_3 - SiO_2 - H_2O$ up to two tectosilicates may coexist with an aqueous solution at any arbitrary temperature and pressure and hence there will be only one zeolite in the presence of a silica phase. In the mixed sodium-calcium system three tectosilicates may coexist and two in the presence of quartz. The occurrence of three-phase zeolite assemblages such as thomsonite-laumontite-analcime at Otama, does not therefore necessarily imply disequilibrium. In cases of variable alkali-alumina ratios or under conditions where non-tectosilicates such as garnet, epidote or prehnite may form, yet another phase will be possible.

4.10. Significance of experimental data

If data on stability fields of minerals are to be applied in petrogenetic interpretation, the actual reactions involved in mineral formation need to be known (note the effects of coupled reactions, FYFE *et al.*, 1958). In some cases these appear