

solutions in contact with albite will produce chemical differentiation. Whether or not such differentiation is significant depends on the volume of solutions and scales of transport involved.

The reported experiments give no direct information about the species in solution. It may be inferred from the pH that the sodium is dominantly in ionic form. The long term stability of the solutions suggests that silica and alumina must be bound up in reasonably stable hydrated complexes. The present treatment does not exclude the possibility that two or even all three of the components of albite may be present in each of the complexes. If this is the case, at least three complexes must be present to explain the varying behavior of silica, alumina, and soda. Assuming that each of these complexes obeys the assumptions made in the present treatment, the thermodynamic analysis presented above would be valid as far as equation (11), with the proviso that each complex contains one or more of the analyzed components. Now the number of moles of the analyzed component is related to the number of moles of the complex by

$$q_k = g q_{12_n} \quad (13)$$

where q_k is the number of moles of analyzed component k in complex 12_n , and g is a constant. Equation (12) can now be rewritten as

$$\ln x_{12_n} = f(P, V, T) \cong \ln (q_{12_n} / q_2) = \ln (q_k / g q_2) = \ln x_k - \ln g \quad (14)$$

In other words, equation (12) can be modified by the addition of a constant only, to give the mole fraction of the analyzed component. The total amount of the analyzed component is easily found by summing equation (14) over all complexes containing the component k

$$\ln X_k = \sum_i (f_i(P, V, T_i) + \ln g_i) \quad (15)$$

This equation is identical in form to equation (12). The form of the solubility equations is therefore independent of the choice of analyzed components; conversely the solubility equations can give no direct information on the species in solution.

POSSIBLE GEOLOGIC SIGNIFICANCE OF ALBITE SOLUBILITY

The maximum measured amount of albite components present in solution of albite reported approximates 2 percent by weight. Considering that the water content of rocks under plutonic conditions rarely exceeds 10 weight percent, the significance of solution processes appears negligible. A model calculation however shows this simple conclusion to be deceptive.

Consider a dehydrating cylinder of radius R , which might be a crystallizing pluton or a body of rocks undergoing progressive metamorphism. Let w be the weight of water per unit volume expelled during the process. Then the total amount of water expelled by a right slice across the cylinder of thickness dz is

$$m_t = \pi R^2 dz w \quad (16)$$

Now consider a cylindrical surface concentric to the dehydrating cylinder but of radius r (greater than R). Consider a segment of this surface subtending angle $d\theta$ and of height dz . Then if the water from the dehydrating cylinder migrates radially outward, the weight of water passing through the element of surface is

$$m = (\pi w R^2 dz d\theta) / 2\pi \quad (17)$$

Now the weight of material per unit area of a thin cylindrical shell of radius r and thickness dr is

$$m_s = D r d\theta dz dr \quad (18)$$

where D is the density. Therefore the ratio of the weight of water passing through the layer to the weight of material in the layer is

$$B = m/m_s = w R^2 / 2rD dr \quad (19)$$

B is inversely dependent on dr , hence for thin layers the weight of water passing through will be large compared to the weight of rock in the layer. Consider a layer 1 cm thick. Substituting into equation 19, some geologically reasonable values, $W = 0.1$ gms/cc, $R = 1$ km (10^5), $r = 10$ km (10^6), and $D = 2.7$ gms/cc, yields $B = 185$. That is, a cylindrical body 1 km in radius, expelling 0.1 gms/cc of water, will cause, at a distance of 9 km from its margin, a total flux of water 185 times the weight of rock locally present, assuming that none of the expelled water is trapped in the rocks immediately surrounding the pluton.

Of course it is a matter of observation that this latter assumption is not true. Aureoles of hydrous minerals either in the body of the rock or along fractures commonly surround plutonic masses. We might therefore replace (16) by the more realistic assumption that the amount of water transported falls off exponentially with distance from the margin of the dehydrating cylinder.

$$m_t = a w R^2 dz \exp(-r/R) \quad (16A)$$

The constant a can be evaluated by noting that (16A) must equal (16) at $r = R$, giving $a = \pi e$. Substituting (16A) in (17) yields in place of equation (19)

$$B = (w R^2 / 2D r dr) \exp(-r/R + 1) \quad (19A)$$

Using the same values as before, we find that a weight of water 0.02 times the weight of rock passes through a surface 9 km from the margin of the pluton and at a distance of 3.5 km from the margin of pluton $B \sim 33$. Even allowing for the escape of volatiles it seems clear that metamorphic or intrusive processes of dehydration will produce large fluxes of water through volumes many times the size of the dehydrating body. The influence of solutions must be far greater than their small amount and low concentration would suggest.

Three important cases suggest themselves: (1) solutions escape suddenly and rapidly from a dehydrating body, (2) solutions escape slowly and uniformly under conditions where the SiO_2/Na ratio exceeds the stoichiometric ratio in albite, (3) solutions escape slowly and uniformly with SiO_2/Na ratio less than that in albite.