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REVIEW PAPER

INVITED CENTENNIAL ARTICLE

Linear partitioning in binary solutions: A review with a novel partitioning array

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ABSTRACT

Linear partitioning refers to a graphical plot of a partition ratio $D \leq 1.0$ against a composition ratio X_2 given as the mole fraction of a refractory component 2. When this plot is linear from $D = 1.0$, $X_2 = 0.0$, its intercept at $X_2 = 1.0$ is a value on the D scale here identified as the value of the exchange coefficient K_D. The plot is generated from phase compositions 1 and 2 in states L_V or L_S or S_S depending on whether the system is a boiling mixture, a melting equilibrium, or a solid-solid equilibrium. The linear partitioning equation so generated is a mathematical description of a binary solution loop, and it has the form $y = ax + b$ where $y \equiv D$, $a \equiv K_D$, $x \equiv X_2$, and $b = 1 - x \equiv 1 - X_2$. In practice, the linearity is tested by regressing values of D against X_2 to find the intercept K_D. If linearity occurs, the system is a binary solution loop; if it does not occur, the system is not a binary loop. Strict linearity is not always observed even in true binary solutions; in such cases the path to K_D may be either segmented or moderately curved. Such is the case with the melting equilibria of both plagioclase and olivine, possibly a clue to the non-ideality of solution. Loop width is an inverse function of K_D, and can vary with pressure as in the case of plagioclase in troctolites and gabbros. Systems with two loops joined at a common minimum or maximum are called azeotropes and all of them show linear partitioning. Sanidine crystalline solutions form a classic example of such behavior. When the system An-Ab is revisited to repeat the Bowen thermodynamic calculation from the latent heats of fusion with modern data, the array shows a single modest curvature. The monoclinic pyroxene pairs augite and pigeonite form a binary loop; augite-orthopyroxene does not. The olivine compositions of rocks in the Kiglapait intrusion follow a linear partitioning line with $K_D = 0.26$ for data above 50% crystallized (50 PCS). All the rocks below 50 PCS occupy a new trend in the linear partitioning diagram. This trend is anchored at $D = 0.0$, $X_2^S = 1.0$ and runs to the calculated liquid composition at its intercept with the $D = 1.0$ upper bound. The new trend is an artifact of a nearly constant liquid composition and serves only to show low Fo contents in the range 0–50 PCS.

Keywords: Binary solutions, linear partitioning, phase equilibrium, plagioclase, olivine, augite, melting, crystallization, Invited Centennial article