

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  $D = 0.0, X_2^i = 1.0$  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.

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