

Degassing of alkalic basalts

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ABSTRACT

In order to model quantitatively exsolution of volatiles over the range of basaltic melt compositions found on oceanic islands, I present compositional parameterizations of H₂O and CO₂ solubilities and use these parameterizations to develop vapor saturation and degassing models for alkalic basaltic liquids. Vapor-saturation diagrams generated as a function of melt composition are used to determine the pressure at which the melt was last in equilibrium with a vapor and the composition of the vapor phase based on measured H₂O and CO₂ contents in basaltic glasses. These models allow the calculation of the pressure at which a magma of known initial volatile content reaches vapor saturation and begins to exsolve a vapor phase. The higher solubility of CO₂ in alkalic magmas causes vapor saturation in CO₂-bearing alkalic magmas to be reached at lower pressures than in CO₂-bearing tholeiitic magmas having identical volatile contents. However, if variations in major element and volatile concentrations were linked by variations in the extent of melting, then volatile-rich, strongly alkalic magmas would begin to exsolve a vapor at slightly higher pressures than volatile-poor alkali olivine basalts or tholeiites.

Partitioning of H₂O and CO₂ into the vapor during volatile exsolution is controlled by the difference between H₂O and CO₂ solubilities. As melts become more alkalic, the relative difference between H₂O and CO₂ solubilities decreases, thus diminishing the preferential partitioning of CO₂ into the vapor. Exsolution of volatiles from tholeiites is characterized by strong partitioning of CO₂ into the vapor such that most or all CO₂ is lost before any significant loss of H₂O. In contrast, the combination of higher CO₂ solubility and higher volatile contents (and perhaps higher CO₂/H₂O ratio) in alkalic melts results in less fractionation between CO₂ and H₂O during volatile exsolution.