

The lawsonite paradox: mineral equilibria modelling in the system $\text{Na}_2\text{O-CaO-K}_2\text{O-FeO-}$ $\text{MgO-Al}_2\text{O}_3\text{-SiO}_2\text{-H}_2\text{O}$

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Lawsonite equilibria are predicted to occur over a broad PT spectrum developed during subduction, yet lawsonite-bearing assemblages are rare. In the context of mafic mineral equilibria modelled for the range of common crustal metamorphism ($P=4\text{--}23$ kbar, $T=400\text{--}750^\circ\text{C}$) using the system $\text{Na}_2\text{O-CaO-K}_2\text{O-FeO-MgO-Al}_2\text{O}_3\text{-SiO}_2\text{-H}_2\text{O}$ and software THERMOCALC, unusually high water contents are demanded by lawsonite assemblages. As a consequence, lawsonite assemblages are predicted to have difficulty forming and lawsonite equilibria to be uncommon. Metabasalt undergoing cooler subduction may experience substantial periods involving the metastable persistence of mineral assemblages due to water under-saturation and recrystallization not occurring. If formed, lawsonite-bearing assemblages are observed to be highly unstable; their preservation requires that exhumation be accompanied by substantial cooling. The amount of structurally-bound H_2O plays a critical role in the formation and preservation of mineral assemblages, controlling key changes in rocks undergoing shallow subduction.