*American Mineralogist, Volume 104, pages 1788–1799, 2019*

# A comparison between the stability fields of a Cl-rich scapolite and the end-member marialite

**Kaléo M.F. Almeida[1,*] and David M. Jenkins[1]**

[1]Department of Geological Sciences and Environmental Studies, Binghamton University, Binghamton, New York 13902, U.S.A.

## Abstract

Scapolites are pervasive rock-forming aluminosilicates that are found in metamorphic, igneous, and hydrothermal environments; nonetheless, the stability field of Cl-rich scapolite is not well constrained. This experimental study investigated two reactions involving Cl-rich scapolite. First, the anhydrous reaction 1 of plagioclase + halite + calcite to form scapolite [modeled as: 3 plagioclase ($Ab_{80}An_{20}$) + 0.8 NaCl + 0.2 $CaCO_3$ = scapolite ($Ma_{80}Me_{20}$)] was investigated to determine the effect of the Ca-rich meionite ($Me = Ca_4Al_6Si_6O_{24}CO_3$) component on the Na end-member marialite ($Ma = Na_4Al_3Si_9O_{24}Cl$). Second, the effect of water on this reaction was investigated using the hydrothermally equivalent reaction 2, $H_2O$ + scapolite ($Ma_{80}Me_{20}$) = 3 plagioclase ($Ab_{80}An_{20}$) + $CaCO_3$ + liquid, where the liquid is assumed to be a saline-rich hydrous-silicate melt. Experiments were conducted with synthetic phases over the range of 500–1030 °C and 0.4–2.0 GPa. For reaction 1, intermediate composition scapolite shows a wide thermal stability and is stable relative to plagioclase + halite + calcite at temperatures above 750 °C at 0.4 GPa and 760 °C at 2.0 GPa. For reaction 2, intermediate scapolite appears to be quite tolerant of water; it forms at a minimum bulk salinity [$X_{NaCl}$ = molar ratio of NaCl/(NaCl+$H_2O$)] of the brine of approximately 0.2 $X_{NaCl}$ at 830 and 680 °C at pressures of 2.0 and 1.5 GPa, respectively. Based on the study done by Almeida and Jenkins (2017), pure marialite is very intolerant of water when compared to intermediate composition scapolite. Compositional changes in the scapolite and plagioclase were characterized by X-ray diffraction and electron microprobe analysis and found to shift from the nominal bulk compositions to the observed compositions of $Ma_{85}Me_{15}$ for scapolite and to $Ab_{91}An_{09}$ for plagioclase. These results were used to model the phase equilibria along the marialite-meionite join in temperature-composition space. This study demonstrates that a small change in the scapolite composition from end-member marialite to $Ma_{85}Me_{15}$ expands the stability field of marialite significantly, presumably due to the high entropy of mixing in scapolite, as well as increases its tolerance to water. This supports the much more common presence of intermediate scapolites in hydrothermal settings than either end-member meionite or marialite as is widely reported in the literature.

**Keywords:** Scapolite, marialite, meionite, solid solution, chlorine, chloride brine, plagioclase