# Appendix

The following thermodynamic expressions were used to calculate the phase diagrams shown in Figures 7a and 7b. The reactions defining the stability of the components $Na_4Al_3Si_9O_{24}Cl$ (= Ma) and $Ca_4Al_6Si_6O_{24}CO_3$ (= Me) in scapolite relative to $NaAlSi_3O_8$ (= Ab) and $CaAl_2Si_2O_8$ (=An) in plagioclase are:

$$3\ NaAlSi_3O_8 + NaCl = Na_4Al_3Si_9O_{24}Cl \tag{A1}$$

$$3\ CaAl_2Si_2O_8 + CaCO3 = Ca_4Al_6Si_6O_{24}CO_3 \tag{A2}$$
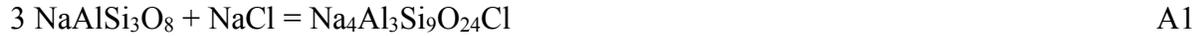
The equilibrium constants corresponding to these reactions are:

$$K_1 = \frac{a_{Ma}^{Scap}}{\left(a_{Ab}^{Plag}\right)^3} \tag{A3}$$

$$K_2 = \frac{a_{Me}^{Scap}}{\left(a_{An}^{Plag}\right)^3} \tag{A4}$$

where a_i^j is the activity of component i in phase j. Substituting the activity-composition relations indicated in equations 4a and 4b for scapolite, the activity coefficients in 5a and 5b for scapolite, and the activity-composition expressions of Newton et al. (1980) for plagioclase into A3 and A4, one has:

$$K_1 = \frac{X_{Ma}^4 \cdot \gamma_{Ma}}{\left(X_{Ab}^2(2 - X_{Ab}) \cdot \gamma_{Ab}\right)^3} \tag{A5}$$

$$K_2 = \frac{\left[4(1 - X_{Ma})^2\left(\frac{1 + X_{Ma}}{2}\right)^2\right] \cdot \gamma_{Ma}}{\left((1/4)(1 - X_{Ab})(2 - X_{Ab})^2 \cdot \gamma_{Ab}\right)^3} \tag{A6}$$

At equilibrium at a given P and T one has:

$$\Delta G_1 = 0 = \Delta G_1^o + RT \ln K_1 \tag{A7}$$

$$\Delta G_2 = 0 = \Delta G_2^o + RT \ln K_2 \tag{A8}$$

where ΔG is the Gibbs free energy of the reaction, $\Delta G°$ is the Gibbs free energy for the pure

phases, R is the universal gas constant (kJ/K·mol), and T is temperature in Kelvins. Expressions

A7 and A8 must be solved simultaneously to find the compositions of scapolite (X_{Ma}) and

plagioclase (X_{Ab}) that satisfy both conditions for equilibrium. Values for $\Delta G°$ were calculated

using the data in Table A1 and the expression:

$$\Delta G°_{P,T} = \Delta H°_{1,298} - T\Delta S°_{1,298} + \int_{298}^{T} \Delta C_P dT - T\int_{298}^{T} \left(\frac{\Delta C_P}{T}\right) dT + \Delta V°_{1,298}(P - P_0) \qquad \text{A9}$$

Table A1. Thermochemical data used in this study from Holland and Powell (2011) and from
Almeida and Jenkins (2017) for marialite.

Phase	$\Delta H°$ 298K, 1bar (kJ/mol)	$S°$ 298K, 1bar (kJ/K·mol)	V 298K, 1bar (kJ/kbar·mol)	$a*$	b (x10^5)	c	d
albite(high)	-3921.49	0.2243	10.105	0.4520	-1.3364	-1275.9	-3.9536
halite	-411.3	0.0721	2.702	0.0452	1.797	0	0
marialite	-12167.49	0.75793	33.035	1.172	9.0626	-4676.4	-8.2379
anorthite	-4232.7	0.2005	10.0790	0.3705	1.001	-4339.1	-1.961
calcite	-1207.88	0.0925	3.6890	0.1409	0.5029	-950.7	-0.858
meionite	-13842	0.752	33.9850	1.359	3.6442	-8594.7	-9.598

* The heat capacity terms (a, b, c, and d) are the coefficients in the expression $C_P = a + b(T) + c/(T^2) + d/(T^{0.5})$, and have units that give the heat capacity (C_P) in kJ/K·mol.