TABLE 1

Chemical analyses and optical properties of lawsonite and anorthite used as starting materials

Oxide	A	B	C
SiO_2	38.14	43.13	44.49
TiO_2	0.29	nd	nd
Al_2O_3	30.91	35.87	36.00
Fe_2O_3	1.56	0.45	0.08
FeO	0.13	0.29	nd
MnO	0.01	nd	nd
MgO	0.03	0.08	0.04
CaO	17.54	19.27	19.49
Na_2O	0.06	0.65	0.59
K_2O	0.14	0.05	0.03
H_2O	10.72		
H_2O+		0.63	nd
H_2O-		0.35	nd
Total	99.53	100.77	100.72

Refractive Indices	A	B	C	D
α	1.665 ± 0.002	1.5748	1.5748	1.57 ± 0.005
γ	1.686 ± 0.002	1.5880	1.5880	1.59 ± 0.005
An %		94.3	94.9	96 ± 2

A. Lawsonite. Analyst, D. Thaemlitz; optical properties, G. A. Davis; Blake Gardens, North Berkeley, California (Davis and Pabst, 1960).

B. Anorthite. Analyst, Y. Kawano; optical properties, I. Kato; crystal lapilli erupted in 1940, Miyake-jima volcano, Tokyo Prefecture, Japan (Kawano and Aoki, 1960).

C. Anorthite. Analyst, H. S. Washington; optical properties, I. Kato; crystal lapilli erupted in 1874, Miyake-jima volcano, Tokyo Prefecture, Japan (Kawano and Aoki, 1960).

D. Anorthite. Miyake Island, Tokyo Prefecture, Japan. Optical properties and universal stage An percent determination, Crawford.

The simplest reactions which field evidence suggests bear on this problem involve:

$$\text{laumontite} = \text{lawsonite} + 2\,\text{quartz} + 2\,\text{water} \quad (1)$$
$$CaAl_2Si_4O_{12} \cdot 4H_2O = CaAl_2Si_2O_7(OH)_2 \cdot H_2O + 2SiO_2 + 2H_2O;$$
$$\text{thomsonite} = \text{lawsonite} + 0.4\,\text{water} \quad (2)$$
$$CaAl_2Si_2O_8 \cdot 2.4H_2O = CaAl_2Si_2O_7(OH)_2 \cdot H_2O + 0.4H_2O.$$

Some data bearing on (1) are available, and we can make some reasonable guesses concerning (2).

Thermodynamic data (table 3) are available for leonhardite, a close relative of laumontite. Coombs (1952) described the conditions for the reversible conversion of laumontite to leonhardite. Laumontite in dry air loses water forming leonhardite, $Ca_2Al_4Si_{18}O_{24} \cdot 7H_2O$. Leonhardite, when soaked in liquid water at room temperature, is converted to laumontite. These observations

TABLE 2

Lawsonite–anorthite experiments

Starting material: Anorthite–lawsonite 1:1 molecular ratio				Starting material: Anorthite–lawsonite–quartz 1:1:4 molecular ratio				Starting material: Anorthite–lawsonite–$CaCl_2$ 1:1 molecular ratio, 0.2 M solution			
Temperature (°C)	Pressure (bars)	Time (days)	Product	Temperature (°C)	Pressure (bars)	Time (days)	Product	Temperature (°C)	Pressure (bars)	Time (days)	Product
515	8900	14	An **(Law)**	515	8900	14	An-Qtz (Law)	400	6950	68	No change
450	7800	70	An **(Law, Zoisite)**	450	7800	70	An-Qtz (Law)	450	6900	76	An (Law, Zoisite)
450	7800	35	Law (An)	450	7800	35	Law (An-Qtz)	450	6210	60	An (Law, Zoisite)
400	6950	68	Law (An)	400	6950	66	Law (An-Qtz)	350	6210	60	Law (An)
400	6950	66	Law (An)	400	6950	30	Law (An-Qtz)	425	6900	60	An (Law)
400	6950	30	Law (An)	350	6100	31	Law (An-Qtz)	400	6210	60	Law (An)
350	6100	31	Law (An)	400	5710	31	An-Qtz (Law)	400	5170	20	An (Law)
450	6900	76	An (Law, Zoisite)	353	5710	31	No change				
450	6210	60	An	450	4140	32	An-Qtz				
350	6210	60	Law (An)	300	4140	64	No change				
375	5530	58	Law (An)	300	4140	31	No change				
400	5170	31	An (Law)	444	2070	33	An-Qtz (Law)				
353	5170	31	No change								
450	4140	32	An								
300	4140	64	No change								
300	4140	31	No change								
444	2070	33	An (Law)								

NOTE: The mineral names appearing in parentheses in the Products columns were detected in minor amount in the product.
An = anorthite; Law = lawsonite; Qtz = quartz.