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Margarite pseudomorphs after chiastolite in the Georgetown area, California

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Abstract

Margarite, paragonite, and muscovite occur together in graphitic metapelites near Georgetown, California. Most of the margarite occurs as a pseudomorphic replacement of coarse-grained chiastolite, whereas muscovite and paragonite are largely confined to the groundmass. Microprobe analyses of the three white micas provide further information about the margarite + paragonite + muscovite three-phase field in the system Al_2O_3–Na_2O–K_2O–CaO–SiO_2–H_2O.

Introduction

Margarite has been recognized as a rock-forming mineral only since the papers of Sagon (1967, 1970) and Frey and Niggli (1972). Guidotti and Cheney (1976) reviewed briefly the several types of margarite occurrences described since these initial studies. One of the apparently common types of occurrence is as aggregates forming pseudomorphs after aluminosilicates—especially in graphitic rocks. This brief report describes a similar paragenesis (discovered by J.L.P.) from the metapelites on the western slope of the Sierra Nevada in California.

This occurrence is of interest because it increases the number of known margarite localities and especially because the specimens contain all three white micas. Hence, knowledge about the orientation of tie lines in the white-mica plane of the system Al_2O_3–Na_2O–K_2O–CaO–SiO_2–H_2O may be further refined. Parageneses containing all three white micas are not common, and some of the recorded occurrences involve a rather celadonitic muscovite (*e.g.* Höck, 1974).

Geologic setting

The specimens were collected from a locality in the Georgetown 7½′ topographic sheet. The specific locality is near the 2600 ft (790 m) contour in Rock Canyon, 2.7 km S35°E of the village of Georgetown, California.

The only geologic mapping that included the specimen locality is that by Lindgren and Turner (1894). As determined from the Sacramento 1:250,000 compilation sheet (Strand and Koenig, 1965), the specimen locality is in undivided Paleozoic marine strata which outcrop just to the east of some bodies of Mesozoic basic and ultrabasic rocks. At the collecting site the strata trend N20°E with vertical dips, and consist of interbedded fine-grained, graphitic muscovite schist and quartzite. Chiastolite, now replaced mainly by margarite, is common in much of the schist, ranging from sparse to up to 50 modal percent in a few beds. The "chiastolite crystals" range from 0.3 to 5.0 cm on the basal plane and up to 15 cm parallel to [001]. In some beds to the east of the locality studied, cursory X-ray work shows that the chiasto-

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TABLE 1A. WHITE MICAS OF SPECIMEN P-1

Spec. #	U.W.[1] Margarite	U.M.[1] Margarite Area 2[7][2]	U.M. Margarite Area 4[5]	U.M. Margarite Sample Ave. [12]	U.W. Paragonite	U.M. Paragonite Area 5[4]	U.M. Muscovite Area 5[7]
FeO	.165	.14	.15	.144	.237	.14	.26
MnO	.028	.03	.02	.026	.020	.03	.04
MgO	.182	.09	.10	.094	.499	.03	.31
CaO	11.196	11.43	10.89	11.205	1.091	1.11	.06
SiO_2	31.761	31.33	31.50	31.401	46.971	46.47	47.71
Al_2O_3	50.493	50.69	50.96	50.802	40.156	40.82	38.07
K_2O	.065	.01	.03	.018	1.515	1.61	7.69
BaO(3)	.039	--	--	--	.058	--	--
Na_2O	1.722	1.54	1.65	1.586	5.784	5.59	1.56
TiO_2	.025	.03	.02	.026	.164	.06	.23
H_2O(4)	4.45	4.71	4.68	4.70	3.58	4.14	4.07
			Formula Based on 22 Oxygen				
Si^{IV}	4.185	4.142	4.155	4.147	5.942	6.119	6.163
Al^{IV}	3.815	3.858	3.845	3.853	2.058	1.881	1.837
Al^{VI}	4.026	4.045	4.084	4.061	3.929	4.027	3.963
Fe	.018	.016	.016	.016	.025	.015	.028
Mg	.036	.019	.020	.019	.094	.007	.060
Mn	.003	.003	.003	.003	.002	.003	.004
Ti	.002	.003	.002	.003	.016	.006	.022
Σ	4.085	4.086	4.125	4.102	4.066	4.093	4.077
K^{XII}	.011	.011	.005	.003	.244	.262	1.269
Na	.440	.396	.423	.407	1.419	1.380	.390
Ca	1.581	1.620	1.540	1.587	.148	.150	.008
Ba	.002	--	--	--	.003	--	--
Σ	2.034	2.017	1.968	1.997	1.814	1.792	1.667
ΣAl	7.841	7.903	7.929	7.914	5.987	5.908	5.800
Σ(Mg+Fe)	.054	.035	.036	.035	.119	.022	.088
Mg/Fe	2.000	1.187	1.250	1.213	3.76	.467	2.143
Na/ΣXII(5)	.216	.196	.215	.204	.784	.770	.234
K/ΣXII	.005	.0005	.003	.002	.135	.146	.761
Ca/ΣXII	.778	.803	.782	.795	.082	.084	.005

(1) *U.W. = analyses done at the University of Wisconsin and U.M. = analyses done at the University of Massachusetts.*
(2) *Area refers to the areal designation on polished thin section. Number in [ ] refers to the number of points analyzed.*
(3) *BaO not analyzed on U. Mass. analyses.*
(4) *Water based on difference from 100%.*
(5) *Sum of XII Sites excludes Ba.*

TABLE 1B. WHITE MICAS OF SPECIMEN P-2

Spec. #	U.W.[1] Margarite	U.M.[1] Margarite Area 4[6][2]	U.M. Margarite Area 2[9]	U.M. Margarite Sample Ave.[15]	U.W. Paragonite (Groundmass)	U.M. Paragonite Area 6[3]	U.W. Muscovite	U.M. Muscovite Area 7[2]
FeO	.121	.15	.15	.15	.158	.16	.302	.42
MnO	.021	--	.01	.006	.022	.04	.031	.05
MgO	.180	.08	.07	.074	.264	--	.756	.81
CaO	11.111	11.09	11.34	11.240	.988	1.74[6]	.098	.04
SiO_2	31.352	31.47	31.53	31.506	45.704	46.03	46.613	47.46
Al_2O_3	51.250	50.86	50.74	50.788	39.197	41.08	35.886	37.12
K_2O	.064	--	--	--	1.121	1.20	7.914	7.51
BaO[3]	.040	--	--	--	.024	--	.190	--
Na_2O	1.656	1.74	1.64	1.68	5.957	5.85	1.372	1.14
TiO_2	.019	.05	.03	.038	.151	.09	.459	.53
H_2O[4]	4.31	4.56	4.49	4.518	6.55	3.81	6.48	4.92
				Formula Based On 22 Oxygen				
Si^{IV}	4.123	4.151	4.158	4.155	5.949	5.841	6.203	6.181
Al^{IV}	3.877	3.849	3.842	3.845	2.051	2.159	1.797	1.819
Al^{VI}	4.067	4.061	4.048	4.053	3.962	3.989	3.831	3.883
Fe	.013	.017	.017	.017	.017	.017	.034	.046
Mg	.035	.015	.014	.014	.051	--	.150	.157
Mn	.002	--	.001	.001	.002	.005	.004	.005
Ti	.002	.005	.003	.004	.015	.009	.046	.052
Σ	4.119	4.098	4.083	4.089	4.047	4.020	4.065	4.091
K^{XII}	.011	--	--	--	.186	.195	1.343	1.248
Na	.422	.445	.419	.429	1.503	1.441	.354	.287
Ca	1.566	1.568	1.603	1.589	.138	.237	.014	.005
Ba	.002	--	--	--	.001	--	.010	--
Σ	2.001	2.013	2.022	2.018	1.828	1.873	1.721	1.540
ΣAl	7.944	7.910	7.890	7.898	6.013	6.148	5.628	5.702
Σ(Mg+Fe)	.048	.032	.031	.031	.068	.017	.184	.203
Mg/Fe	2.692	.882	.823	.847	3.000	.000	4.411	3.413
Na/ΣXII[5]	.211	.220	.207	.213	.823	.769	.207	.186
K/ΣXII	.005	.000	.000	.000	.102	.104	.785	.810
Ca/ΣXII	.783	.779	.793	.787	.075	.127	.008	.003

Footnotes (1)-(5) as on Table 1A

(6) This value seems anomalously high. Moreover, the analysis of this specimen involves counts only on three points.

TABLE 1-C.

WHITE MICAS OF SPECIMEN P-3.

Spec. #	U.W.[1] Margarite
FeO	.133
MnO	.027
MgO	.127
CaO	11.134
SiO_2	31.084
Al_2O_3	51.617
K_2O	.057
BaO[3]	.029
Na_2O	1.682
TiO_2	.017
H_2O[4]	4.22
Formula Based on 22 Oxygen	
Si^{IV}	4.086
Al^{IV}	3.914
Al^{VI}	4.082
Fe	.015
Mg	.025
Mn	.003
Ti	.002
Σ	4.127
K^{XII}	.010
Na	.429
Ca	1.568
Ba	.002
Σ	2.009
ΣAl	7.996
$\Sigma(Mg+Fe)$	.040
Mg/Fe	1.667
$Na/\Sigma XII$[5]	.214
$K/\Sigma XII$	.005
$Ca/\Sigma XII$	.781

Footnotes as on Table 1A

TABLE 1D. WHITE MICAS OF SPECIMEN P-4.

Spec. #	U.W.[1] Margarite	U.M.[1] Margarite Area 3[5][2]	U.M. Margarite Area 4[5]	U.M. Margarite Sample Ave.[10]
FeO	.181	.17	.20	.19
MnO	.026	.03	.02	.03
MgO	.168	.03	.03	.03
CaO	11.289	11.59	11.68	11.64
SiO_2	31.365	31.40	31.15	31.28
Al_2O_3	50.315	50.35	50.97	50.66
K_2O	.068	--	.02	.01
BaO[3]	.030	--	--	--
Na_2O	1.775	1.64	1.70	1.67
TiO_2	.024	.08	.05	.07
H_2O[4]	4.90	4.71	4.18	4.42
	Formula Based On 22 Oxygen			
Si^{IV}	4.157	4.156	4.106	4.131
Al^{IV}	3.843	3.844	3.890	3.869
Al^{VI}	4.016	4.016	4.027	4.022
Fe	.020	.019	.022	.021
Mg	.033	.007	.005	.006
Mn	.003	.003	.002	.003
Ti	.002	.008	.005	.007
Σ	4.074	4.053	4.061	4.059
K^{XII}	.011	--	.003	.002
Na	.456	.421	.433	.427
Ca	1.603	1.644	1.651	1.648
Ba	.002	--	--	--
Σ	2.072	2.065	2.084	2.077
ΣAl	7.859	7.860	7.921	7.891
Σ(Mg+Fe)	.053	.026	.027	.027
Mg/Fe	1.650	.368	.227	.286
Na/ΣXII[5]	.220	.204	.208	.206
K/ΣXII	.005	.000	.001	.001
Ca/ΣXII	.774	.796	.792	.793

Footnotes as on Table 1A