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CHLORINE AND FLUORINE IN MICAS OF PELITIC SCHISTS FROM THE SILLIMANITE-ORTHOCLASE ISOGRAD, MAINE

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ABSTRACT

Coexisting muscovite and biotite averaged $\leq$0.01 and 0.03% Cl and 0.07 and 0.2% F, respectively by microprobe analysis. The F is partitioned regularly between biotite and muscovite. The amounts of halogens are too small to account for divariant behaviour of equilibria.

The apparent divariant behavior in the field of theoretically univariant equilibria, some of which define isograds, has been ascribed in some recent studies to the buffering of the fugacity of a volatile constituent by solid phases present in proportions that overwhelm the vapor phase (Evans and Guidotti, 1966; Trommsdorff, 1968).

With regard to H_2O-liberating reactions, there has been a tendency to overlook the influence on equilibria of (OH)-substitutes, particularly the halogens. At one atmosphere it is clear that fluor-micas and fluor-amphiboles are stable to much higher temperatures than the hydroxyl analogues (Van Valkenburg and Pike, 1952; Wones, 1967; Ernst, 1968), but the differences are considerably reduced at even moderate water pressures (Fyfe *et al.*, 1958, p. 161–163). Nevertheless, despite the lack of experimental data on F-OH-micas, it can safely be assumed that their high temperature breakdown will be fractional, and that, given enough fluorine, a "divariant" assemblage such as OH-F-muscovite+sillimanite +orthoclase+quartz+fluid could exist in pelitic schists over an appreciable range in temperature.

According to Deer *et al.* (1962, p. 14) the average F content of natural muscovite is 0.6 percent. If true for metamorphic parageneses, it could have a profound effect on muscovite stability relations.

Chlorine and fluorine have been determined by microprobe analysis (Table 1) on the coexisting micas of pelitic schists and gneisses from the vicinity of the sillimanite-orthoclase isograd in northwest Maine (Evans and Guidotti, 1966). Chlorine averages $<$0.01 percent and 0.03 percent in muscovite and biotite respectively (for biotite .02% below and .04% above the isograd). Fluorine tends to be an order of magnitude higher in both micas, in muscovite typically $<$0.1 percent and in biotite 0.1 to 0.5 percent. Despite clear indications of grain-to-grain variability of F in biotite, there is a coherent partitioning of F between biotite and muscovite (Fig. 1). No correlation between Cl and F was observed.

TABLE 1. CHLORINE AND FLUORINE CONTENTS OF COEXISTING MUSCOVITE AND BIOTITE[a]

Specimen number[b]	Muscovite		Biotite	
	Cl%	F%	Cl%	F%
3	0.00X	0.10	0.02	0.29
4	.00X	.11	.02	.46
5	.01	.05	.01	.34
6	.01	.01	.02	.12
8	.00X	.09	.03	.50
9	.00X	.02	.01	.20
10	.00X	.06	.02	.18
11	.00X	.08	.02	.41
12	.00X	.09	.03	.28
13	.00X	.03	.02	.12
16	.00X	.03	.02	.18
18	.00X	.08	.03	.25
19	.00X	.03	.02	.23
31	.00X	.07	.03	.27
38			.04	.19
41	.00X	.07	.03	.23
51			.06	.25
52	.00X	.10	.03	.29
53	.00X	.04	.04	.28
55			.12	.35
63	.00X	.10	.02	.22
65	.01	.03	.02	.18
67			.05	.20
69	.00X	.05	.03	.16
70	.00X	.11	.03	.25
71			.01	.27
72	.00X	.07	.03	.21

[a] Data given are averages of at least 10 spot determinations per mineral. Chlorine figures accurate to $\pm 0.01\%$ absolute; standardized with scapolite ON8; detection limit 0.005%. Fluorine data believed accurate to $\pm 0.1\%$F absolute when amount is less than 0.5%; biotite U. C. #3 with 3.3%F used as standard; because of large absorption uncertainty and grain-to-grain variability, no attempt at absorption correction was made; detection limit 0.05%F; second decimal place retained for statistical purposes. Analytical conditions: Applied Research Laboratories EMX microprobe, 10 kV accelerating potential, 0.3 microamps specimen current, KAP analyzing crystal, and pulse height selection.

[b] Specimen numbers correspond to those in Evans and Guidotti (1966, Table 1): 1 to 26 from below the sillimanite-orthoclase isograd, 27 to 72 from above.

Contents of F and Cl in muscovite are clearly too small for the divariant character of the sillimanite-orthoclase isograd to be attributed to halogens. It would appear to be rather more difficult to justify such a

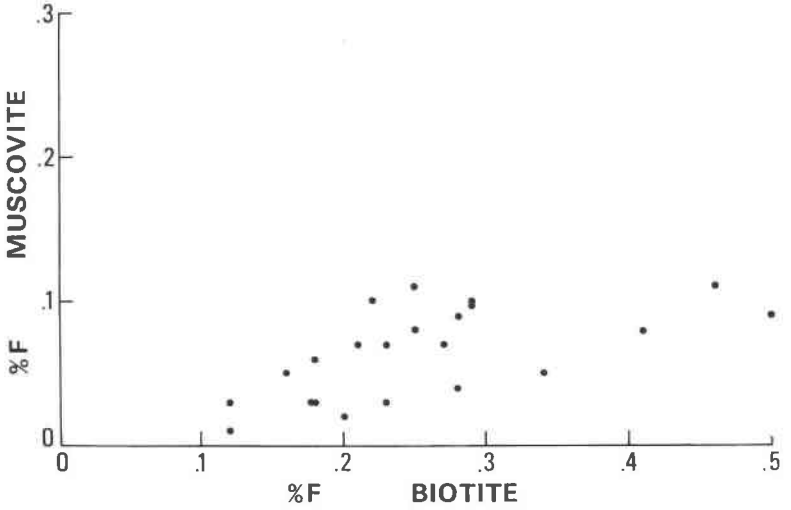

FIG. 1. Correlation between F in coexisting muscovite and biotite, pelitic schists, Maine.

conclusion in the case of an isograd involving the breakdown of biotite.[1] The preferential acceptance of F and Cl by biotite rather than coexisting muscovite, recognized some time ago (Correns, 1956), makes much safer the application of experimentally-determined equilibria in halogen-free systems to natural occurrences of muscovite than to biotite.

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[1] In the pyroxene hornfels assemblage: cordierite+orthoclase+biotite, fluorine in biotite when present in small amounts can be as high as 2.5%, e. g., Comrie aureole, Scotland, U. C. Berkeley coll. 792-20A: 2.1%F, 792-40B: 2.5%F, 792-14A: 0.1%F, although Cl=0.75%.