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[*Manuscript received 11 September 1972*]

MINERALOGICAL MAGAZINE, JUNE, 1973, VOL. 39, PP. 251–3

Biotites in calc-alkaline intrusive rocks

FOLLOWING the initial work of Heinrich (1946), Foster (1960) examined the relationships between biotite compositions and generalized geological occurrences. She found that biotites from varieties of calc-alkaline intrusive rocks show considerable overlap when the *Y* site cations are plotted on triangular diagrams with (Al^{vi}, Fe^{3+}, Ti^{4+}), (Fe^{2+}, Mn^{2+}), and Mg^{2+} as apices, indicating that no simple correlation between biotite composition and host-rock types exists. However, Foster suggested that this overlap, in part, may be due to the loose usage of rock names such as 'granite'. The objects of this study are to revise Foster's diagram especially for intrusive calc-alkaline rocks using a rigorous rock classification and to test if the conclusions reached by the previous study are substantiated.

Analyses of biotites from calc-alkaline rocks were selected from the literature (sources quoted in the list of references) on the following criteria: a mode of the host rock was available; the rock was substantially free of metamorphism, weathering, and hydrothermal alteration. These criteria, especially the first, meant the rejection of many analyses; a total of 125 were finally selected. The analyses were divided into seven groups on the basis of host rock modes, following the classification of Streckeisen (1967): syenogranite (9), monzogranite (33), granodiorite (37), quartz diorite (21), monzonite (4), monzodiorite (11), and diorite (10). Cation abundances for each biotite were calculated to 44 anions (water and halogen free) using the computer program of Jackson *et al.* (1967).

The data are plotted on fig. 1*a*. It can be seen that the spread of analyses is similar to that found by Foster (1960, fig. 11), with no analyses in the phlogopite field but several being (Fe^{2+}, Mn^{2+})-rich. Fig. 1*b* shows the fields of biotite compositions from the various rock types. Biotites from monzonites, monzodiorites, and diorites (with the exception of one from the Guadalupe complex, which was ignored for the purposes of delineating the field) have similar, restricted compositions, which are Mg^{2+}-rich.

Biotites in quartz diorites and granodiorites overlap the field of those from the quartz-poor rocks, but trend to more (Fe^{2+}, Mn^{2+})-rich compositions. The field of biotites from monzogranites encompasses almost the complete spread of analyses. Biotites in syenogranites have two distinguishing features: they are all (Fe^{2+}, Mn^{2+})-rich and, in general, are richer in (Al^{vi}, Fe^{3+}, Ti^{4+}) than those from the more mafic rocks.

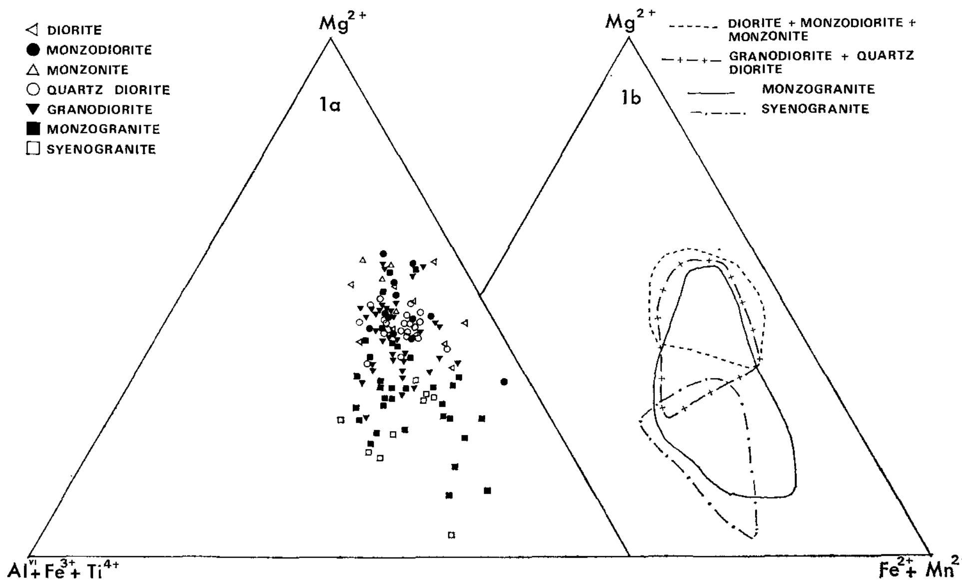

FIG. 1, *a* and *b*: *a*, left, plot of *Y* site cations of biotites from calc-alkaline intrusive rocks. *b*, right, fields of biotite compositions from various calc-alkaline intrusive rocks.

The following conclusions can be reached: firstly, moderately Mg^{2+}-rich biotites occur in most calc-alkaline intrusive rocks, a conclusion already reached by Foster (1960). Secondly, the only biotites characteristic of a specific rock type are those from the syenogranites, which are (Fe^{2+}, Mn^{2+})- and (Al^{vi}, Fe^{3+}, Ti^{4+})-rich. We consider the trend towards (Fe^{2+}, Mn^{2+})-rich biotites in the monzogranites and syenogranites may reflect, in part, the strong enrichment of iron relative to magnesia in the silica- and potash-rich members of the calc-alkaline association.

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[*Manuscript received 21 August 1972*]

MINERALOGICAL MAGAZINE, JUNE 1973, VOL. 39, PP. 253–5

Unusual zircons from the Leinster Pluton

ZIRCONS having elongation ratios greater than 69 have been found in muscovite flakes collected from the Leinster Granite. The greatest recorded elongation ratio known to the author is 32 for a zircon from the Pend Oreille tonalite (Poldervaart, 1956, p. 535).

Six samples of 50 to 80 gms of muscovite were collected, three from the muscovite-rich Type III granite (Brindley, 1954, p. 161) and three from different pegmatites. The zircons were separated by dissolving the muscovite flakes in a mixture of HF and H_2SO_4 (see Larsen and Poldervaart, 1957). The pegmatite muscovites were found to contain no zircon. In contrast the granite muscovites contained numerous extraordinarily elongate zircons. A fundamental environmental difference is indicated (Brindley and Gupta, 1973, p. 426).