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An Investigation on the Composition of Chlorite Replacing Biotite from the Canadian Appalachian granites

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This paper is aimed to provide chemical data on chlorites, the alteration product of biotite which is the dominant ferromagnesian mineral in the Paleozoic granitic rocks of the Canadian Appalachians, and to interpret their composition with respect to host biotites and rock types to obtain a better understanding of its occurrence, since no attempt has been made so far to characterize them in these rocks. 54 chlorite and host biotite specimens, taken from different granitic plutons in New Brunswick and Newfoundland provinces, were analyzed by electron microprobe for major elements and by 57Fe Mössbauer spectroscopy for determination of oxidation state of Fe. Mössbauer spectra of chlorite show no evidence of any tetrahedral Fe3+, consistent with the structural formulae that Fe3+ does not substitute for Si; instead, Al substitutes for Si between the limits of 0.95 to 1.41 atoms per four tetrahedral sites. Comparison of Mössbauer Fe3+/Fe ratios obtained from chlorite and its host biotite indicates that chloritization might have occurred under relatively oxidizing conditions. Based on the microprobe data, most of the compositional variations in chlorite reflect large differences in the iron, magnesium, silicon and aluminum contents. Mineral recalculation data show that Si cation totals of these sheet silicates are less than 6.25 atoms per formula unit (apfu), and the sum of octahedral cations is very close to 12 both an indication of trioctahedral chlorite (Xie et al. 1997). The calculated mole fraction of chlorite in interlayered phase (Bettison and Schiffman, 1988) Xc, ranges from. 0.72 to 0.98 confirming that the chlorites are completely free of any smectite layers (López-Munguira1 et al. 2002). Compositional variations in chlorite are strongly controlled by host biotite and rock type. Fe/(Fe+Mg) ratio ranges from 0.35 to 0.93 and Si contents from 5.18 to 6.11 apfu lead to the classification of chlorites mainly as ripidolite and brunsvigite. All major elements in the chlorite are strongly correlated with each other and Fe/(Fe+Mg) ratio in biotite is well preserved by chlorite. It can be concluded that the breakdown of biotite into chlorite was accompanied by the following chemical changes: decrease in SiO2, K2O and TiO2; increase in H2O, MgO, FeOtotal and MnO and slight increase in Al2O3. The enrichment of Fe, Mn and Mg in chlorite relative to biotite may be related to structural differences between these minerals.
Chlorite thermometry based on the variation in tetrahedral Al content within the chlorite structure (Cathelineau and Nieva, 1985) shows a large variation in temperatures from 200 to 390 ºC with an average of 340 ºC. The chlorite from igneous rocks could also be used to detect reheating events and reveal the thermal history of the rocks.

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