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# The Formation of Sulfides during Alteration of Biotite to Chlorite-Corrensite<sup>†</sup>

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**Abstract:** Transmission electron microscopy/analytical electron microscopy (TEM/AEM) were utilized to study pyrite and sphalerite inclusions in chlorite or mixed-layer chlorite-corrensite from an analcimized ash bed in the Etalian stage (Middle Triassic), South Otago, New Zealand. These sulfide inclusions occur as elongated crystals up to  $1 \times 15 \mu\text{m}$  in size, within lens-shaped voids between separated, deformed (*001*) layers of (primarily) chlorite and mixed-layer chlorite-corrensite grains of typical detrital shape or chlorite packets in chlorite-mica stacks (intergrowths of chlorite and phengite packets) up to  $40 \times 150 \mu\text{m}$  in size. Relict biotite layers within chlorite, mixed-layer chlorite-corrensite and berthierine have textures implying replacement of the former by the latter, whereas in other unaltered samples only fresh biotite was observed. Anatase occurs in otherwise Ti-free chlorite, whereas relict biotite contains significant Ti (0.3 moles per 22 oxygen atoms). No sulfide minerals have been found in fresh biotite and phengite.

Mass balance considerations indicate that S and Zn were introduced via pore fluids and that the Fe was provided by the decomposition of biotite to secondary phyllosilicates. The alteration of biotite and the reaction of biotite to form chlorite and pyrite is controlled by  $a\text{H}^+/a\text{K}^+$  as well as oxidation of reduced S species or reduction of oxidized S species from solution. Simple calculations with the observed compositions of chlorite and biotite suggest that some of the Fe in biotite was actually removed in solution rather than precipitated in pyrite and chlorite. Similar textures are abundant in ferroan phyllosilicates elsewhere, implying that the mechanism may apply widely to precipitation of sulfides in phyllosilicates during early diagenesis of sediments.

**Key Words:** TEM • AEM • Altered Biotite • Biotite • Chlorite • Corrensite • Hydrobiotite • Pyrite • Sphalerite

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