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Chlorite and biotite weathering, Fe^{2+}-rich corrensite formation, and Fe behavior under low P_{O_2} conditions and their implication for Precambrian weathering

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Abstract

Fresh and weathered granite from drill cores in Tono, Gifu, Japan, was examined to understand weathering products and the mechanisms of chlorite and biotite weathering under low P_{O_2} conditions. A fresh sample from 365 m depth, a slightly weathered light-green sample from 367 m depth, and a nearly fresh sample from 369 m depth (but with brown stains on fractures), were investigated. The XRD, SEM, EMPA, and TEM analysis of green grains present within chlorite, biotite, and plagioclase grains and in veins was found to be Fe^{2+}-rich corrensite [about 40 wt% FeO with Fe/(Fe + Mg) = 0.94]. The corrensite is interpreted to have formed from chlorite and biotite via a dissolution-precipitation mechanism. The <2 μm fraction of the weathered sample had an $Fe^{2+}/\Sigma Fe$ value of 0.69, which, when combined with the presence of amorphous Fe^{3+} (hydr)oxides confirmed by TEM, indicates that the $Fe^{2+}/\Sigma Fe$ value of corrensite is >0.69. These results indicate that on dissolution of chlorite and biotite, Fe^{2+} was transported as Fe^{2+} and precipitated as Fe^{2+}-rich corrensite and a part of the dissolved Fe^{2+} was oxidized to amorphous Fe^{3+} (hydr)oxides under low P_{O_2} conditions. The formation of Fe^{2+}-rich corrensite and that of Fe^{2+}-rich smectite or vermiculite in the laboratory at 1 atm of P_{CO_2} and $\leq 3 \times 10^{-5}$ atm of P_{O_2} (Murakami et al. 2004) suggest that a possible Fe^{2+}-bearing product during Precambrian weathering is Fe^{2+}-rich sheet silicates but not siderite.

Keywords: Weathering, corrensite, Fe behavior, low O_2, atmospheric evolution, granite, TEM