

Iron behavior during Archean weathering predicted by anoxic dissolution of biotite

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Fe-rich biotite dissolution experiments were carried out under an anoxic condition (PO_2 less than 3×10^{-5} atm) at 1 atm of PCO_2 , pH 4.6, and 100 degrees for 7 to 120 days in a batch system to examine anoxic weathering processes and Fe behavior during Archean weathering. The released amount of Fe(II) from Fe-rich biotite into solution was much larger under the anoxic condition than the present atmospheric condition under which Fe-rich biotite dissolution experiments were also conducted at pH 4.7 and 100 degrees for comparison. High resolution scanning and transmission electron microscopy revealed that Fe(II)-rich vermiculite or smectite was formed as a secondary mineral. The formation is in contrast with Fe(III) (hydr)oxides formation under oxic conditions. As anoxic weathering proceeds, Fe(II)-rich vermiculite or smectite probably decomposes into kaolinite and further releases Fe(II) to water. The releases of Fe(II) into water from primary and secondary Fe-bearing minerals, well explain the large loss of Fe from pre-2.2 Ga paleosols. The Fe/Mg ratio of the vermiculite or smectite was higher than that in the fresh biotite. Because Fe(II)-rich vermiculite or smectite formed by anoxic weathering is the most likely precursor of chlorite in paleosols, the higher Fe/Mg ratio should result in higher Fe/Mg ratios of chlorite than those of primary Fe-bearing minerals, which is consistent with the results of detailed geochemical studies of the Hekpoort paleosol, South Africa and the Cooper Lake paleosol, Canada.