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Solid solution in the celadonite family: The new minerals ferroceladonite, $K_2Fe^{2+}_2Fe^{3+}_2Si_8O_{20}(OH)_4$, and ferroaluminoceladonite, $K_2Fe^{2+}_2Al_2Si_8O_{20}(OH)_4$

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ABSTRACT

Celadonite-family mica minerals occurring in the Triassic Gavenwood Tuffs, Murihiku Supergroup, Hokonui Hills, Southland, New Zealand, have been analyzed by XRD, TEM, AEM, and EMPA. Packets a few unit cells to several hundred nanometers thick are intimately intergrown with chlorite, berthierine, and corrensite. Analyses of homogeneous packets, combined with analyses from the literature, imply complete or nearly complete solid solution between end-members of the celadonite family defined by octahedral exchange involving $MgFe^{3+}$, $Fe^{2+}Al$, $Fe^{2+}Fe^{3+}$, and probably MgAl, and show that EMPA analyses are commonly contaminated by mixtures. Two new minerals of the celadonite family are defined: ferroceladonite, $K_2Fe^{2+}_2Fe^{3+}_2Si_8O_{20}(OH)_4$, and ferroaluminoceladonite, $K_2Fe^{2+}_2Al_2Si_8O_{20}(OH)_4$. The former occurs largely as submicrometer ($\leq$ 200–300 nm thick) grains in vesicle rims, and the latter admixed with chlorite and mixed-layered minerals in vesicle interiors and replacing glass shards. Heulandite is intimately associated with both ferroceladonite and ferroaluminoceladonite. Both new minerals are blue-green in thin section and occur as 1*M* polytypes. Powder X-ray diffraction patterns of mixtures show only one set of mica peaks, with only a few peaks exhibiting slight broadening. The strongest lines in the X-ray powder diffraction patterns are [*d* (*I*, *hkl*)]: 3.65 (52, $11\bar{2}$); 3.358 (86, 022); 3.321 (100, 003); 3.090 (60, 112); 2.584 (50, $13\bar{1}$). A composite sample composed of ferroceladonite and ferroaluminoceladonite gives the following unit-cell data: space group *C*2/*m*, *Z* = 2, with refined average lattice parameters *a* = 5.270(5), *b* = 9.106(7), *c* = 10.125(8) Å, β = 100.27 (14)°, *V* = 478.1(4) Å^3. The calculated densities are 3.045 (3) and 2.928 (2) g/cm^3 for ferroceladonite and ferroaluminoceladonite, respectively. Celadonite mineral-aluminous clay mineral and celadonite mineral-Ca-rich zeolite assemblages of the zeolite facies are related to illite-chlorite ± pumpellyite assemblages of higher grade by dehydration reactions, not necessarily under closed-system conditions.