American Mineralogist, Volume 106, pages 1172–1182, 2021

Ferropyrosmalite-bearing fluid inclusions in the North Patagonian Andes metasedimentary basement, Argentina: A record of regional metasomatism

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Abstract

Quartz segregations in paragneisses from the Paleozoic basement of the North Patagonian Andes contain highly saline multiphase fluid inclusions with the rare daughter mineral ferropyrosmalite detected by Raman analysis, besides halite, sylvite, hematite, and/or magnetite. During heating experiments, L-V homogenization occurs (256–515 °C), followed by halite dissolution (287–556 °C) and the dissolution of ferropyrosmalite at 550–581 °C. The latter phase transition triggers the growth of clino-amphibole crystals according to the following idealized reactions, written for potential end-members:

$$4Fe_8Si_6O_{15}[(OH)_6Cl_4] + 6Ca^{2+}(aq) \leftrightarrow 3Ca_2Fe_5Si_8O_{22}(OH)_2 + 17Fe^{2+}(aq) + 16\,Cl^-(aq) + 12OH^- + 3H_2$$
Ferropyrosmalite ↔ Ferro-actinolite

$$Fe_8Si_6O_{15}[(OH)_6Cl_4] + 2Ca^{2+}(aq) + Fe^{3+}(aq) + 2Al^{3+}(aq) + Na^+(aq) + H_2O \leftrightarrow NaCa_2(Fe_4^{2+}Fe^{3+})(Al_2Si_6)O_{22}Cl_2 + 4Fe^{2+}(aq) + 2Cl^-(aq) + 4H_2$$
Ferropyrosmalite ↔ Chloro-hastingsite

The amphibole resembles the composition of ferro-actinolite but also has striking similarities with chloro-hastingsite, as indicated by Raman spectroscopy. During the heating experiment, hematite (when present) transforms to magnetite by the uptake of H_2, whereas inclusions without Fe-oxides contain traces of H_2 after the reaction. This mineral transformation shows that ferropyrosmalite might result from the retrograde re-equilibration of amphibole with the brine, implying the uptake of Fe^{2+}, Cl^-, and H_2O and the enrichment of Ca^{2+} in the brine. Pervasive fluid flow and fluid-assisted diffusion are recorded by channel way microstructures, healed microfractures, and dissolution-reprecipitation phenomena, as demonstrated by cathodoluminescence microscopy. These alkali- and $FeCl_2$-rich brines, derived from magmatic sources and of possible Mesozoic age, were related to regional metasomatism, coeval with widespread granitoid activity.

Keywords: Ferropyrosmalite, ferro-actinolite, chloro-hastingsite, fluid inclusions, Raman spectroscopy, fluid-assisted diffusion