

SHORT COMMUNICATION

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Identification of ferropyrosmalite by Laser Raman microprobe in fluid inclusions from metalliferous deposits in the Cloncurry District, NW Queensland, Australia

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ERROPYROSMALITE, an iron-rich member of the pyrosmalite series $[(\text{Fe},\text{Mn})_8\text{Si}_6\text{O}_{15}(\text{OH},\text{Cl})_{10}]$, has been discovered as one of the most common daughter minerals in multiphase fluid inclusions from many Cu–Au–Co and Pb–Zn–Ag deposits in the Cloncurry District, NW Queensland, Australia. The deposits are hosted by mid Proterozoic supracrustal sequences that were strongly deformed and metamorphosed during the 1.62–1.50 Ga ‘Isan’ orogeny (Blake and Stewart, 1992). Cu–Au–Co mineralization is spatially and temporally related to the late to post-orogenic Williams and Naraku Batholiths and a magmatic origin for the mineralizing fluids has been proposed by Adshead (1996) and Williams *et al.* (1995). The origin of Pb–Zn–Ag deposits is more controversial, with syngenetic, epigenetic and hybrid models having been proposed (Vaughan and Stanton, 1986; Chapman 1993; Walters and Bailey, 1996).

The fluid inclusions studied occur in hydrothermal infill and alteration quartz, which is closely associated with sulphide mineralization. They contain liquid, vapour, and more than three solid phases at room temperature (Fig. 1). Relative proportions of the main solid phases vary from sample to sample, but are similar within individual quartz grains. This suggests that the solid phases are daughter minerals rather than captive phases. One of the common daughter minerals in the fluid inclusions is colourless to pale green, stubby or prismatic with high relief and moderate birefringence. Laser Raman

microprobe analysis indicates this mineral has a Raman spectrum with distinct bands at 615 cm^{-1} and 1022 cm^{-1} (Fig. 2). Electron microprobe analysis of stubby or prismatic solids in opened inclusions yields distinctive Si, Fe, Mn and Cl X-ray peaks (Fig. 3).

Ferropyrosmalite occurs as a common retrograde hydrothermal phase in mineral deposits in the Cloncurry district, including the Pegmont Pb–Zn–

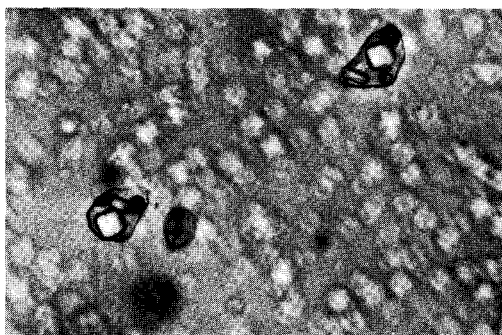


Fig. 1. Photomicrograph of two multiphase fluid inclusions from the Cannington Ag–Pb–Zn deposit, both contain a vapour bubble, a large cubic halite, a prismatic ferropyrosmalite and a small crystal of K–Pb–chloride. The inclusions are about 15 μm in diameter.

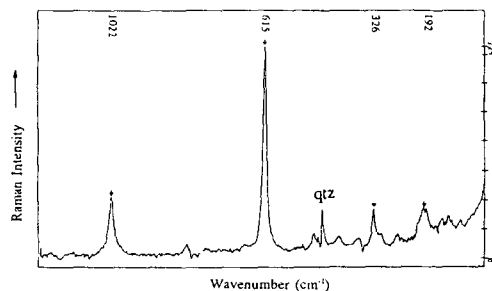


FIG. 2. Laser Raman spectrum of the prismatic daughter mineral in a multiphase fluid inclusion from the Osborne Cu–Au–Co deposit.

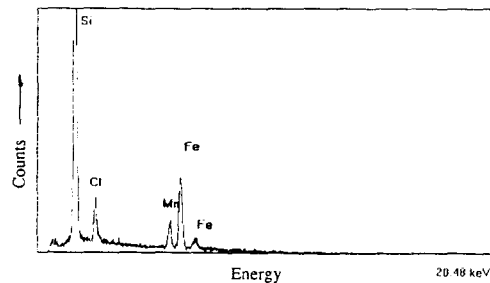


FIG. 3. Energy dispersive spectrum of a prismatic daughter mineral in an opened inclusion from the Cannington Ag–Pb–Zn deposit.

Ag deposit (Vaughan, 1986), the Cannington Ag–Pb–Zn deposit (Boden, 1996) and the Osborne Cu–Au deposit (Adshead, 1996). At Cannington, ferropyrosmalite occurs in veins and as a replacement of pyroxmangite, olivine, hedenbergite and garnet (Boden, 1996). Laser Raman microprobe analysis of ferropyrosmalite from the Cannington deposit gave a spectrum identical to that of the daughter mineral in the fluid inclusions (Fig. 4a). The electron microprobe spectrum of the ferropyrosmalite also shows a similar pattern to those of the stubby or prismatic solids in opened inclusions, although the intensity of the Si X-ray peak is often higher in the latter spectra and could be partly derived from the quartz host (Fig. 4b). It is therefore believed that the stubby or prismatic daughter crystal in the fluid inclusions is ferropyrosmalite.

During heating experiments the majority of the inclusions decrepitated or stretched prior to total homogenization. Only a few of them survived, and the ferropyrosmalite was nearly always the last phase to be left in the inclusions. With continuous heating, the ferropyrosmalite displayed one of the following three behaviours: (1) complete dissolution at temperatures of 430–505°C, these are also the total homogenization temperatures of the inclusions; (2) transition of the ferropyrosmalite crystal into a new solid phase via dissolution of the ferropyrosmalite crystal and simultaneous growth of a new round or prismatic crystal, beginning at 410–465°C and completed at about 430–510°C; and (3) stable and virtually no detectable decrease in size up to 520°C (the maximum temperature used in this study). The high homogenization temperatures are considered to represent the temperature of the mineralizing fluid prior to ore deposition (e.g. Adshead, 1996).

This is the first report of ferropyrosmalite as a daughter mineral in fluid inclusions. Caution should be exercised in the identification of daughter

minerals using conventional optical properties and SEM techniques. Both ferropyrosmalite and Fe-(Mn)-chloride share many common features, e.g. similar crystal form, colour, relief, birefringence and SEM spectrum if the host mineral is quartz. In this particular case, Laser Raman microprobe analysis has provided an excellent tool to distinguish Fe-(Mn)-chloride from ferropyrosmalite.

It should also be noted that the second strongest band at 1022 cm^{-1} in the Raman spectrum of ferropyrosmalite is very close to the strongest band at 1019 cm^{-1} in the spectrum of anhydrite (Dubessy *et al.*, 1983). Ferropyrosmalite could easily be misidentified as anhydrite if the analysis was only undertaken in the region 800–1200 cm^{-1} where many minerals show characteristic bands. It is therefore necessary to scan the whole region if the presence of ferropyrosmalite or anhydrite is suspected.

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Terry Mernagh of Australian Geological Survey Organisation and Bob Riel of James Cook University are sincerely thanked for their assistance during Laser Raman microprobe and electron microprobe investigations. The manuscript has benefited from the comments by Pat Williams and two anonymous Mineralogical Magazine reviewers. Funding for this study was from an Australian Research Council Small Grant.

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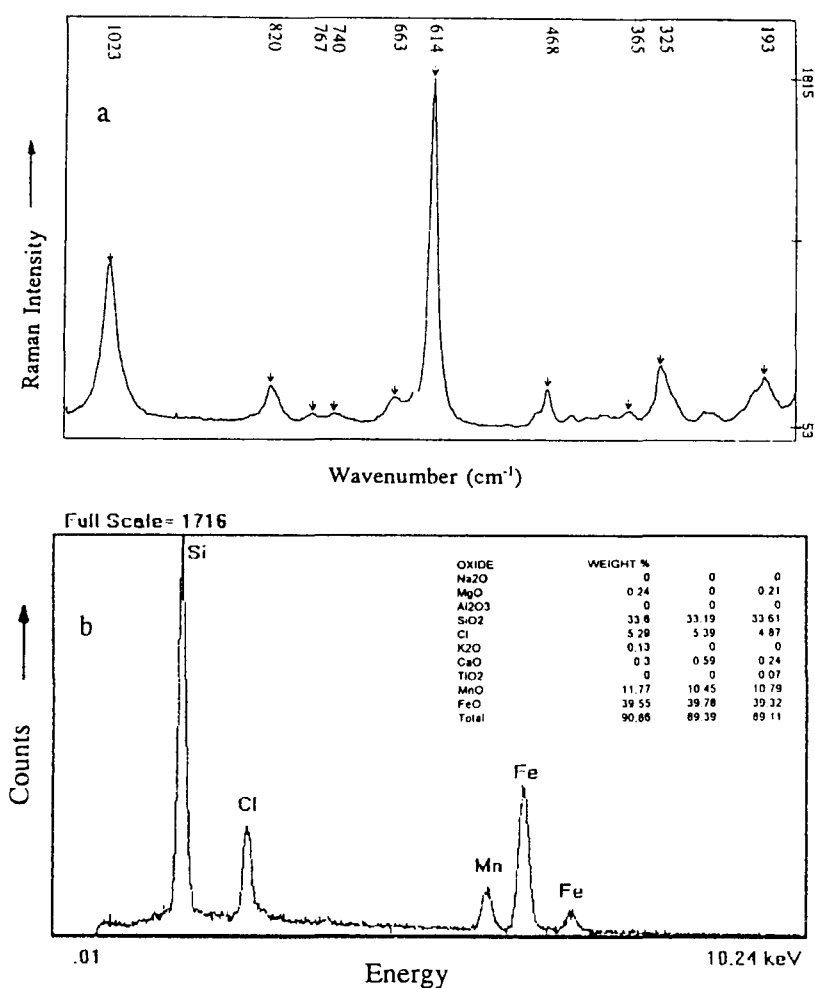


FIG. 4. Laser Raman spectrum (a) and energy dispersive spectrum with electron microprobe data (b) of ferropyrosmalite from the Cannington Ag–Pb–Zn deposit.

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