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A Raman micro-spectroscopic study of fluid inclusions in yellow danburite

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Danburite, a calcium borosilicate, CaB2Si2O8, can be associated genetically with rocks of magmatic (pegmatoid), metasomatic (skarn) and sedimentary (evaporite) origin. Yellow danburite belongs to the extremely rare gem group. Recently, several yellow danburite crystals were discovered in an alluvial deposit, in the Luc Yen mining area, northern Vietnam. The identification of sassolite crystals in fluid inclusions points to a pegmatite origin of the Luc Yen danburite (Smirnov et al., 2000) and this confirms with the low-density values of carbon dioxides which were obtained from Raman measurements using the Fermi doublet as a function of fluid density.

Materials and Methods
Three danburite crystals (158, 3.8 and 3.3 ct) were used for this study. Raman spectra of inclusions were collected in the confocal mode using a Jobin Yvon LabRam HR800 micro-spectrometer equipped with an Olympus BX41 optical microscope and a Si-based CCD (charged-coupled device) detector. Peak analysis of CO_2 was performed with an OriginLab 9.0 professional software package, and the peaks were fitted using a Gauss-Lorentz function.

Results and Discussion
Fluid inclusions arrange as single or along trails inside the danburite crystal. Trails are oriented both parallel and perpendicular to the c-axis of the host crystals, composed of two- or multi-phase inclusions. Two-phase inclusions typically consist of a liquid (H_2O-rich) phase and a vapor bubble (CO_2) phase that differ in their degrees of fill suggesting heterogeneous entrapment of the dominant fluid during crystal growth. The dominant multi-phase is characterized by multiple sassolite crystals, a liquid H_2O phase and a pure CO_2 vapor bubble. The sassolite crystals appear usually as colourless pseudohexagonal plates showing more or less perfect crystal faces and vary from 5μm to 50μm in size. Sassolite shows two distinct bands at 500 and 880 cm–1 and two additional bands at 3165 and 3247 cm–1. Raman spectra of CO_2 show two main bands at about 1388 cm-1 and 1285 cm 1 which are known as the Fermi diad. The separation between the Fermi diad bands (Δ) was found to be a function of CO_2 density in fluid inclusions whereby the separation increases with increasing density of CO_2. The Δ values fall in the range from 102.7 to 103.7 cm 1 which corresponds to densities lower than 0.4 g/cm3 (Wang et al., 2011). The low-density CO_2 in liquid inclusions in danburite from Luc Yen is in accordance with those found in minerals of granitic pegmatite origin (Bakker and Schilli, 2016).

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