Fluid Inclusions of Quartz-Carbonate Veins in the Canadian Rocky Mountains

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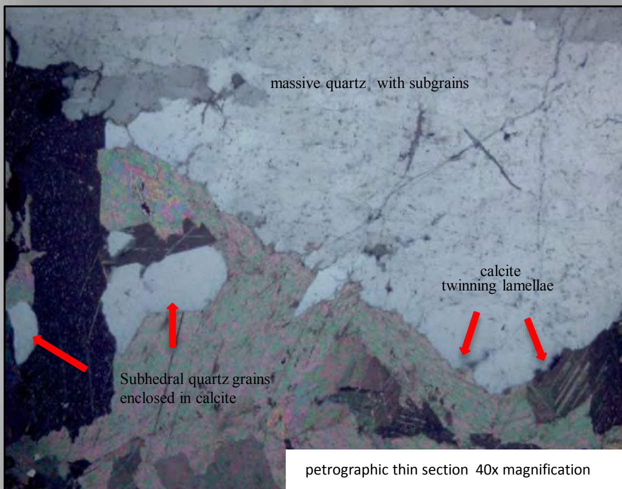
Vein systems in crustal rocks record a variety of processes, including fluid migration and extensive mass transfer, [1] and they preserve information about the composition, temperature, and pressure conditions that mitigate rock-fluid interaction during vein formation. [2] This study will attempt to characterize the formational sequence and origin of fluid inclusions observed in several samples extracted from a quartz-carbonate vein system in the Canadian Rocky Mountains, and explore the role of fluid-rock interaction in the formation of these veins. Preliminary observations of thin sections taken from vein samples are detailed conjointly with petrographic images and a brief review of the formation and significance of fluid inclusions in rock-hosted vein systems.



petrographic thin section 40x magnification

fluid Inclusion thin section 600x magnification

fluid Inclusion thin section 600x magnification

Methods

Several hand samples were taken from the centre and vein-wall boundary of a 20-40 cm wide vein extending roughly 10 m through Paleozoic bedrock between Field and Golden, British Columbia, east of the Purcell Thrust. From selected hand samples, one petrographic thin section and one fluid inclusion thin section were made, with a thickness of 30 μ and 200 μ, respectively. The petrographic thin section was analyzed under cross polarized light (xpl), with an initial emphasis on observation of the physical properties of its component mineral grains. The fluid inclusion thin section was analyzed under plain polarized light (ppl) to determine whether fluid inclusions were present and, if so, to observe and describe their physical properties.

(1) Ague, J.J., 2003, Treatise on Geochemistry, Pergamon: 195-228.
(2) Penniston-Dorland, S.C., Ferry, J.M., 2008, American Mineralogist, 93, 7-21.
(3) Hollister, L. S., and M. L. Crawford, eds. *MAC Short Course in Fluid Inclusions*. Mineralogical Association of Canada, 1981.
(4) Blamey, N.J.F. and Norman, D.I., 2001, Stanford Geochemical Workshop.

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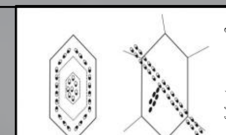
Preliminary Observations

The presence of calcite in the vein are indicated in the petrographic thin sample by high birefringence in xpl, uniaxial negativity, and twinning lamellae. In the hand specimen, the mineral thought to be calcite demonstrated a hardness of 3, rhombohedral cleavage, effervescent reaction to dilute HCL, an earthy to vitreous luster, opaque yellow- to pinkish-white colour, and subhedral to anhedral growth quality. Quartz is indicated in thin section by low birefringence in xpl, uniaxial positivity, and lack of cleavage. Mineral growths suspected to be quartz demonstrated a hardness of 7, no HCL reaction, an opaque to translucent milky white color, a vitreous luster, and massive habit with no cleavage. Subgrains present in the massive quartz in the upper right quadrant of the petrographic thin section suggest dynamic deformation, whereas quartz grains enclosed by calcite crystal are anhedral and show little or no deformation, possibly indicating multiple generations of crystal formation/fluid pulses.

The 200 μ thin section shown in the centre and right images above has several regions of densely packed and variously sized fluid inclusions visible at 600 x magnification. Fluid inclusions form most commonly when metamorphic or meteoric fluids are trapped during mineral growth, forming primary fluid inclusions that occur within mineral grains, or secondary fluid inclusions that crosscut mineral grains.[3] Numerous fluid inclusions observed in the thin section, as shown in the above centre image, contain visible vapor bubbles. Vapor bubbles formed in these inclusions when supercritical fluids, which, unable to undergo phase separation, entered a host rock and became trapped in an aqueous-dominant state; subsequent cooling and pressure change through time allows gas to come out of solution, and the resultant vapor bubbles are retained within the fluid inclusion.[4] The 200 μ thin section, as shown in the above right image, included regions where fluid inclusions formed multiple unidirectional lineations, perhaps suggesting that differential pressure and internal crystal structure influenced their formation within the vein.



Primary and Secondary Fluid Inclusions

Future Directions

The next phase of this study will focus on a more detailed analysis of mineral and vein-wall boundary samples using an electron probe microanalyzer and microthermometry to reconstruct the formational stages of the fluid inclusions and the fluid composition and temperature during inclusion formation. Stable isotope analysis will assist in establishing the original source of the fluids that compose the fluid inclusions.