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830594FLUID INCLUSION STUDY OF THE CHAPPELLE
AND LAWYERS PROPERTIES, BRITISH COLUMBIA

OBJECTIVE OF STUDY: To construct the geologic history of the mineralized areas of the Chappelle and Lawyers properties employing fluid inclusion data.

RESULTS: The morphology and distribution of primary fluid inclusions in quartz crystals, as well as the low salinities of the primary inclusions, is suggestive of quartz growth in open fault-controlled structures at low temperatures (<300°C). However, some quartz from the Baker Mine contains secondary inclusions of high-temperature (>300°C), high-salinity (>25 wt% NaCl eq.), and/or high CO₂ content.

The nature of the samples prevented definitive determination of the timing of the introduction of the precious metals.

**INTERPRETATION OF
GEOLOGIC HISTORY:**

1. Deposition of Takla Group Rocks
2. Deposition of Toodoggone rocks (earliest Hazelton Group)
3. Formation of low T (<225°C), low-salinity (<3 wt% NaCl eq.) quartz veins at Chappelle and Lawyers properties
4. Intrusion of Omineca batholith and associated syenomonzonite and quartz-feldspar porphyry plugs. During this event, euhedral quartz (formed in step 3 above) is fractured and/or crushed, and heated to high temperatures (>300°C).
5. Late, low-temperature, low-salinity quartz is deposited (samples F and G), perhaps contemporaneously with euhedral pyrite.

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PROCEDURE

Fourteen samples from the Chappelle and Lawyers properties were submitted by Thomas Drown for standard fluid inclusion analysis. Fifteen thin (<150 μ m), doubly-polished plates were prepared without subjecting the samples to temperatures exceeding room temperature during the polishing process. All plates were then surveyed to determine the types, kinds, sizes, and relative abundances of fluid inclusions present. Temperature and salinity determinations from select samples were obtained with a FLUID INC. adapted U.S.G.S. Gas-Flow Heating/Freezing System which operates by passing preheated or cooled N₂ gas directly over the sample. Homogenization temperature accuracy is better than 1% of the measured value except for vapor-rich inclusions ($\pm 25^{\circ}\text{C}$). Freezing point depressions are accurate within 1 $^{\circ}\text{C}$. Fluid inclusions were homogenized before they were subjected to freezing tests. Weight percent NaCl eq. salinities were computed by the method of Potter, Clynne, and Brown (1978, EG, 73, p. 284) for inclusions which were undersaturated with respect to NaCl at room temperature. Those inclusions saturated with NaCl at room temperature contain a halite daughter mineral, and salinities were computed by the method described in Potter, Babock, and Brown (1977, J. Research U.S. Geological Survey, V.5, p. 389-395).

RESULTS

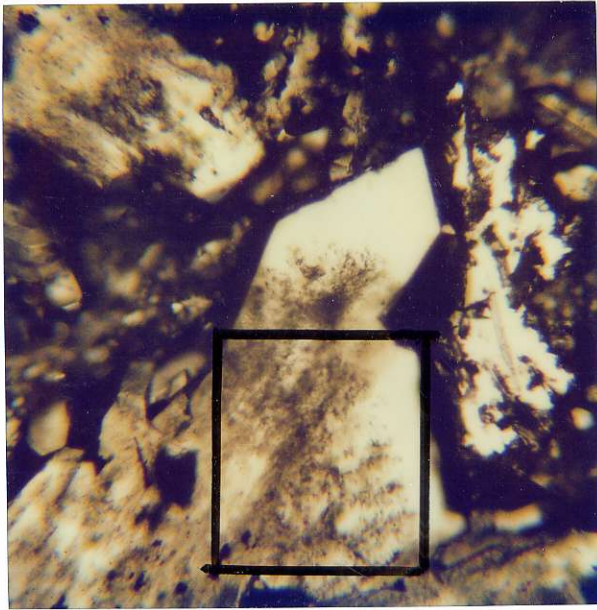
Types of Fluid Inclusions Identified

- ① Type I inclusions are two-phase inclusions (H₂O liquid and H₂O vapor) which homogenize by disappearance of the vapor bubble. Many samples contain ubiquitous Type I inclusions which have been leaked or decrepitated due to subsequent natural overheating postdating their formation.
- ② Type II inclusions are two-phase inclusions (H₂O liquid and H₂O vapor) which homogenize by disappearance of the liquid phase.
- ③ Type III inclusions are three-or-more-phase inclusions containing halite as a daughter mineral at room temperature, as well as liquid and vapor H₂O phases. These inclusions homogenize by disappearance of the vapor bubble.
- ④ Type IV inclusions are two-or three-phase CO₂-bearing inclusions that may homogenize either by disappearance of the vapor bubble or by disappearance of the liquid phase.

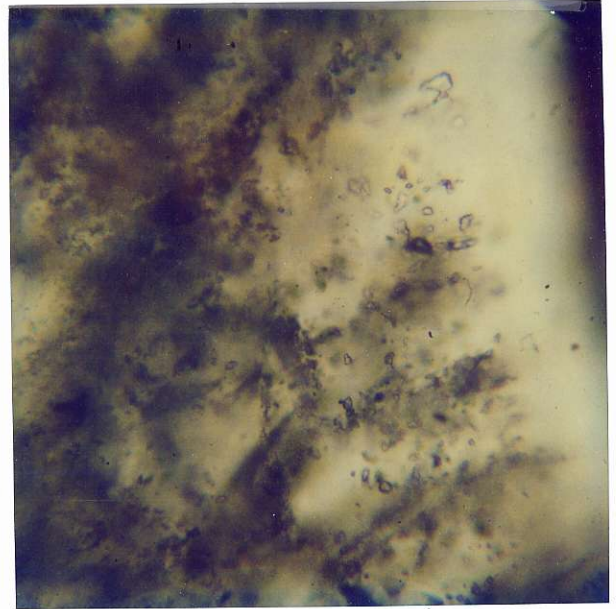
Kinds of Fluid Inclusions Identified

Primary and secondary fluid inclusions in quartz are identified as the relative time of trapping by the enclosing mineral could be determined. Primary fluid inclusions form at the time of crystal growth and thus trap the fluids from which the enclosing mineral grows. Secondary inclusions form from healing of microfractures trapping fluids which bathe a mineral at some time after crystal growth ceases. (Each temperature reported for secondary inclusions below is from 1 inclusion of a plane of inclusions yielding consistent results.)

The primary inclusions in quartz are not only distinctive, but have characteristics equivalent to quartz found from previously studied precious metal deposits which occur in major fault-controlled structures. Figure 1 shows photomicrographs of euhedral quartz from an fault-controlled silver mine in New Mexico. Figure 2 shows photomicrographs of euhedral quartz from the Baker Mine, British Columbia. The distribution of fluid cavities displayed in Figures 1 and 2 are referred to in this report as dendrite cavities because these fluid inclusions have been significantly altered by subsequent overheating. Only salinities could be determined from these primary inclusions.

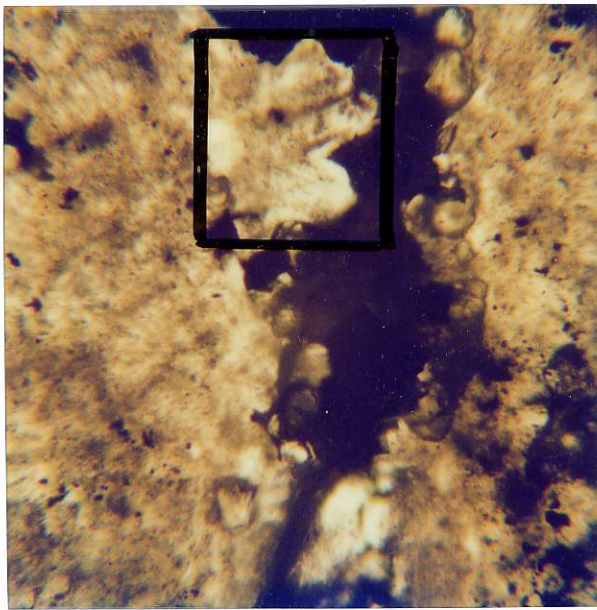


A

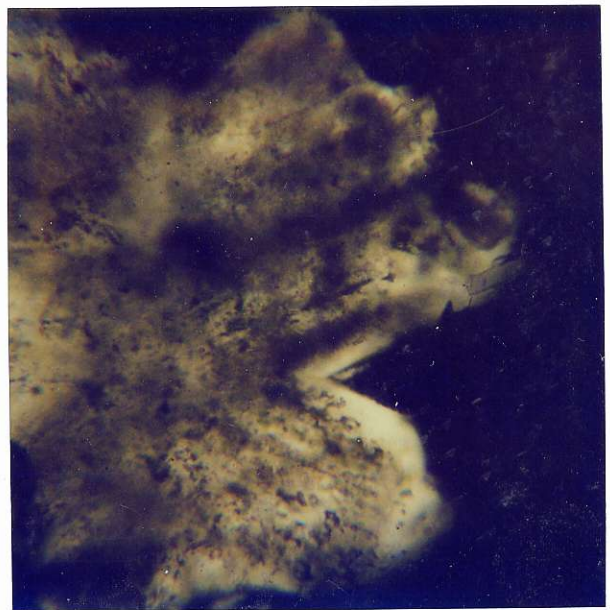


B

Figure 1. Euhedral quartz crystals that are cloudy due to radiating dendritic textures defined by primary fluid inclusions. B is an enlargement of an area in A. From a silver mine in New Mexico.



A



B

Figure 2. Same as Figure 1, but sample collected from the Baker Mine, British Columbia (5245-814e-5625 e1).

Fluid Inclusion Data

The fluid inclusion data are summarized in Tables 1-4 and are reviewed here. All samples from the Baker Mine and Lawyers Prospect, as well as sample C from West Chappelle and sample A from Vein C contain abundant dendrite cavities described above. Sample G from the Lawyers prospect contains quartz with textures identical to those found in the Baker Mine as well as other, finer-grained euhedral quartz. All of these samples contain secondary high-temperature ($>300^{\circ}\text{C}$) inclusions (Tables 2 and 3) except for sample F from Lawyers which contains only low-temperature ($<180^{\circ}\text{C}$), low-salinity (<3 wt% NaCl eq.) primary fluid inclusions (see Table 4). Samples D and E from West Chappelle and sample B from Vein C contain few examples of the dendrite cavity texture and little, if any, sulfides.

DISCUSSION

The morphologies and distribution of primary fluid inclusions in mineralized and unmineralized samples from the Chappelle and Lawyers properties is indicative of quartz growth in open spaces. Homogenization temperatures that might have been obtained from the primary inclusions in these samples were not collected as the data would have been held in suspect because of the presence of secondary fluid inclusions which homogenize at high temperatures. Several salinity determinations were obtained from primary inclusions in a sample from the Baker Mine (Table 2). These primary inclusions are of low-salinity, which supports the hypothesis that the quartz formed from fluids dominantly meteoric in origin.

The presence of high-temperature inclusions as secondaries requires that the quartz must have been present prior to local intrusive activity. The high-salinity inclusions are most probably magmatic in origin, and there is a good possibility that the vapor-rich and CO_2 -bearing fluids also are derived from magmatic processes.

Certainly, the entire district cooled as intrusive activity waned, and young veins were probably formed, as well as young material deposited in older structures, during this final cooling process. The ribboned quartz vein cutting trachyte porphyry at the Lawyers property (sample F) containing primary fluid inclusions ($T_h < 180^{\circ}\text{C}$, salinity < 3 wt% NaCl eq.) perhaps records this natural retrograde process. Low-temperature (highly-necked) planes of secondary inclusions found in samples from the Baker Mine could also be storing the last hydrothermal fluids that circulated.

In summary, three distinct fluids could have circulated through the structures at the Chappelle and Lawyer's properties: an early, low-temperature, low-salinity, dominantly meteoric fluid, a magmatic fluid derived from local intrusive activity; and late, dominantly meteoric fluids, which circulated as the intrusives cooled. PRECIOUS METALS COULD HAVE BEEN DEPOSITED FROM ANY ONE OR ALL OF THESE HYDROTHERMAL FLUIDS. Nevertheless, based on the characteristics of the samples studied and reviewed in this report, there is an empirical correlation of ore-bearing rock with the relative abundance

of dendrite cavities in quartz crystals. This relationship supports the possibility that the precious metals and sulfides (as the precious metal-bearing minerals often replace sulfides) were present prior to introduction of plutons and the associated high-temperature fluids.

CONCLUSIONS

Ample evidence supports the contention that the majority of the quartz from the Baker Mine formed in an open structure from fluids of low salinity and probably at temperatures less than 200°C. It is also clear that fluids at high temperatures (>300°C) and of probable magmatic origin circulated through the same structures constituting the Baker Mine. There is a strong probability that even later fluids circulated as the nearby batholith and associated intrusives cooled.

Since any of these fluids are capable of transporting precious metals, it would be inappropriate to rule out the possibility of a vein containing ore based on the presence or absence of a specific fluid signature. Thus, knowing which fluid is responsible for ore-grade mineralization may not be important in this case. However, if future surveys of fluid inclusion textures from the Chappelle and Lawyers properties consistently show that dendrite cavities are abundant in precious metal-bearing samples and absent in barren samples, then this empirical relationship might prove to be a valuable exploration tool in these districts.

TABLE 1. Summary of Observations

<u>Sample #</u>	<u>Subhedral-Anhedral sulfides?</u>	<u>Euhedral Pyrite?</u>	<u>Dendrite Cavities?</u>	<u>Low T incs? (<200°C)</u>	<u>High T incs? (<300°C)</u>	<u>High CO₂ incs?</u>
5245n-814e-5625e1	abundant	rare	abundant	destroyed/rare	present	present
5440n-875e-5590e1	abundant	rare	abundant	destroyed/rare	present	present
5245n-614e-5625e1	abundant	rare	abundant	destroyed/rare	present	present
4930n-725e-5490e1	abundant	rare	abundant	destroyed/rare	present	present
4930n-725e-5500e1	rare	rare	abundant	destroyed/rare	present	present
5245n-614e-5625e1	present	present	abundant	destroyed/rare	present	present
C: West Chappelle	abundant	rare	abundant	destroyed/rare	present	present
D: West Chappelle	present	present	few	--	--	--
E: West Chappelle	present	abundant	few	--	--	--
A: Vein C	rare	present	abundant	destroyed/rare	present	--
B: Vein C	rare	present	few	--	--	--
G: Lawyers	abundant	rare	abundant	destroyed/rare	present	--
H: Baker	absent	absent	abundant	destroyed/rare	present	--
F: Lawyers	absent	absent	abundant	present	absent	absent

TABLE 2. Data from sample 5245n-814e-5625e1: Baker Mine Ore

Secondary, liquid-rich, high-salinity H₂O incs in quartz:

<u>T_h</u>	<u>T_s</u>	<u>sal.</u>
422°C	187°C	31 wt% NaCl ew.
>600	179	31
>600	210	32
>600	301	38

Secondary, vapor-rich H₂O incs in quartz:

<u>T_h</u>	<u>T_{mp}</u>	<u>sal.</u>
294°C	-12.3	16.3 wt% NaCl eq.
401	-3.2°C	5.3
410	-3.6	5.9
440		
509	-14.8	18.6

Secondary H₂O-CO₂ incs in quartz:

<u>T_{mp}_{CO₂}</u>	<u>T_{mp}_{clathrate}</u>	<u>T_h_{CO₂}</u>	<u>T_h_{total}</u>
-56.6°C	+7.7°C	+20°C	244°C to liq.
-56.7	+7.9	+19	decrepitated
--	+6.4	--	360 to vapor
--	+2.5	--	365 to vapor

Freezing point depressions of leaked primary incs in dendrite growth zones in quartz:

<u>T_{mp}</u>	<u>sal.</u>
-0.4°C	0.7 wt% NaCl eq.
-0.6	1.1
-0.6	1.1
-0.6	1.1
-0.8	1.4
-0.9	1.6
-1.1	1.9
-1.2	2.1
-1.3	2.2
-1.4	2.4
-1.4	2.4

TABLE 3. Data from sample H: narrow quartz vein cutting Hogem Syenite in Baker Mine

Secondary, liquid-rich H₂O inclusions in quartz:

<u>T_h</u>	<u>T_{mp}</u>	<u>sal.</u>
311°C	-0.8°C	1.4 wt% NaCl eq.
326		
332	-0.8	1.4
333	-1.0	1.7
334	-0.9	1.6
335	-1.0	1.7
343	-1.2	2.1
345	-1.2	2.1
351		

TABLE 4. Data from sample F: ribboned quartz vein cutting trachyte porphyry at Lawyer's property:

Primary inclusions in quartz:

<u>T_h</u>	<u>T_{mp}</u>	<u>sal.</u>
97°C		
99		
108		
116		
130		
133		
145	-0.5	0.9 wt% NaCl eq.
148	-0.9	1.6
150		
152		
154		
159		
159		
161	-0.9	1.6
162		
163		
166	-0.7	1.2
167	-1.6	2.7
171		
175		
177		