GENETIC IMPLICATIONS OF FLUID INCLUSION STUDIES CINOLA GOLD DEPOSIT QUEEN CHARLOTTE ISLANDS

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INTRODUCTION

At the Cinola gold deposit Miocene sedimentary rocks, a shale sequence, and a coarse clastic sequence of fluviatile origin were intruded by a Middle Miocene stock of quartz feldspar porphyry (Champigny and Sinclair, 1980). The mineralized system, exposed over an area of more than 1 square kilometre, consists of an intensively silicified zone with late-stage veins and stockworks superimposed on both the rhyolitic intrusion and the adjacent sedimentary rock sequence. Silicified host rocks and veins contain about 3 per cent disseminated pyrite and marcasite with submicroscopic and rare visible gold. Other sulphides and oxides are seldom observed. The veins are divided into four successive events on the basis of form and crosscutting relationships. These are black to grey chalcedonic quartz (earliest) and hematitic quartz, white and cherty quartz, and calcite (youngest). Quartz deposition began before formation of all sulphides (mainly pyrite) and native gold and continued during deposition of these opaque minerals. Veins at Cinola exhibit crustification, ribbon texture, and development of drusy vugs; some calcite crystals attain 2 centimetres in length. This report describes preliminary studies of fluid inclusions in fracture-controlled, gold-bearing veins present in the Cinola orebody. Samples for this study were collected from drill core during the summer of 1979.

DESCRIPTION OF FLUID INCLUSION

Six specimens of quartz were selected to test the application of fluid inclusion data to the development of a genetic model for the deposit. The specimens were collected to represent a large area of the Cinola mineralized system. Fluid inclusions range from 5 to 47 microns in their longest dimension and all have two phases: a liquid and a vapour that total from 1 to 15 volume per cent and average 5 volume per cent. Most of the inclusions were along crystal growth zones, but some are from crystals developed in vugs or as crustiform layers. There is no evidence of deformation and we feel confident that inclusions studied are primary.

HOMOGENIZATION DATA

Homogenization temperatures by vapour disappearance were recorded from 36 inclusions (Fig. 74). The population is bimodal with a low temperature mode between 150 and 160 degrees celsius and a higher temperature mode between 270 and 280 degrees celsius. These two populations of filling temperatures probably represent at least two episodes of mineral deposition and mineralization within the late-stage white quartz and calcite veins. Of seven measurements above 275 degrees celsius, five were from translucent quartz cementing pebbles and matrix in a conglomerate unit. This accords with an early stage of deposition of quartz cement observed by Champigny and Sinclair (1980).

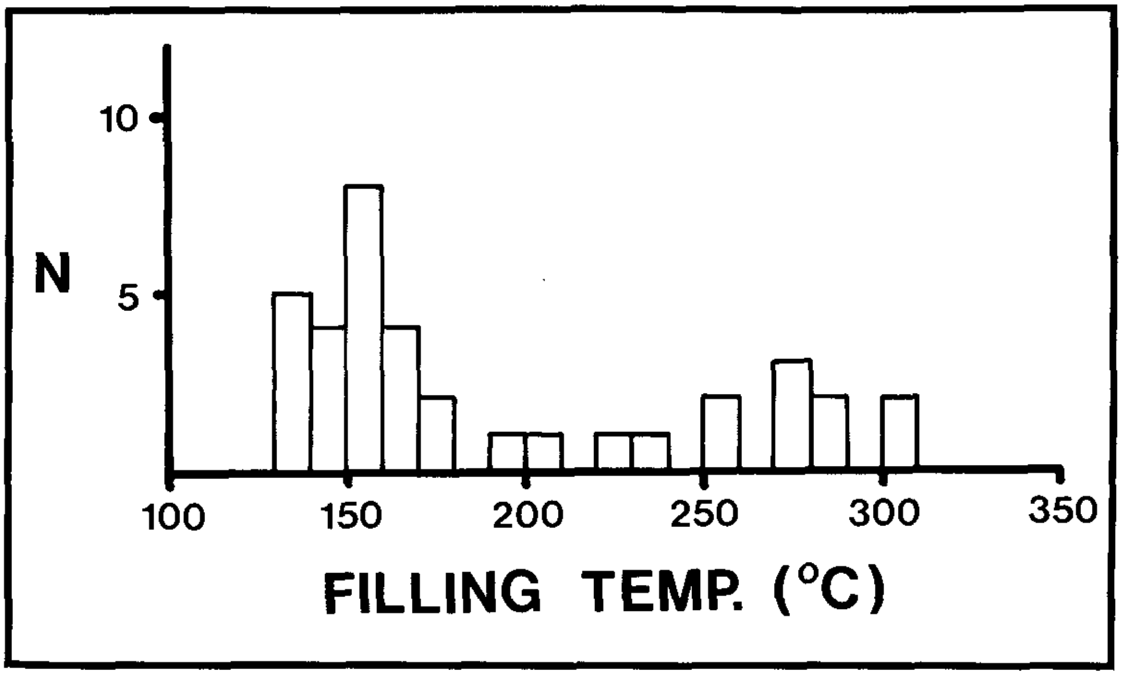

Figure 74. Histogram of homogenization temperatures of fluid inclusion in quartz, Cinola deposit.

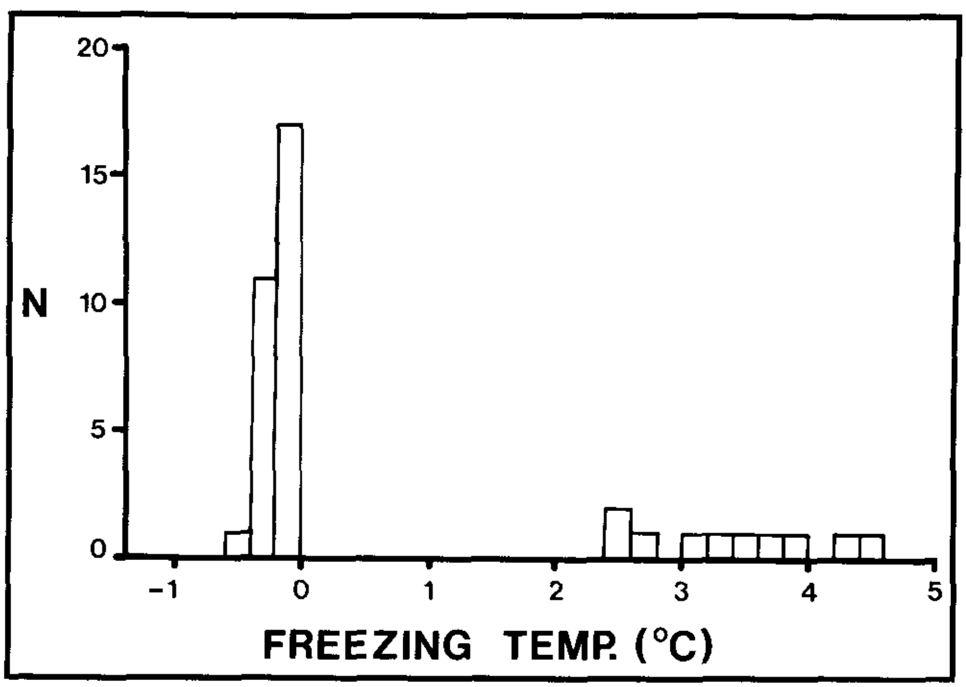

Figure 75. Histogram of freezing temperatures of fluid inclusions in quartz, Cinola deposit.

FREEZING DATA

Most of the freezing temperatures measured from 39 inclusions fall between -0.1 and -0.5 degrees celsius (Fig. 75). Temperatures from 2.5 to 4.9 degrees celsius are considered to be evidence for the presence of dissolved CO_2 (clathrates) in the aqueous solution (Collins, 1979). Melting points of these clathrates ranged from 3.0 to 3.4 degrees celsius and from 2.5 to 4.9 degrees celsius in the two samples where they were observed. Double freezing, a characteristic phenomenon of clathration, was very difficult to observe because the inclusions and gas bubbles are small. Salinity estimates for the inclusion fluids were obtained using the formula of Potter, *et al.* (1978). NaCl equivalent in solution varies from 0.2 to 0.9 weight per cent with an average of 0.4 weight per cent. Small amounts of CO_2 may be trapped in the ore fluid but would not significantly change the estimated salinities (Collins, 1979, Fig. 5).

PRESSURE CORRECTIONS

The homogenization data are not corrected for the effects of pressure. Host rocks at Cinola are mainly conglomerates which correlate with the base of the Skonun Formation as found in the Tow Hill well (Sutherland Brown, 1976). Sixty-five kilometres to the northeast of Skonun Point exposed Skonun sedimentary rocks are weakly cemented and highly porous. This, combined with the extensive fracturing in the mineralized zone, suggests that pressure during vein deposition was hydrostatic. Average thickness of the Skonun sedimentary rocks from five wells drilled is 1 200 metres, and 1 760 metres of strata is present at Tow Hill. At these depths hydrostatic pressure is approximately 117 and 172 bars respectively. From this pressure corrections of 15 degrees celsius or less for a solution of 1 per cent NaCl equivalent could apply (Potter, 1977), that is, actual temperatures of deposition are no more than 15 degrees celsius higher, on average, than the filling temperatures reported here.

DISCUSSION

From the homogenization and freezing data, it is apparent that mineralizing fluids at Cinola had a relatively low and only slightly variable salinity. They contained very minor amounts of NaCl equivalent and CO_2. Low salinities are characteristic of gold quartz veins and Carlin-type deposits (Nash, 1972) and are consistent with a meteoric origin for the ore fluids. In the present case superheated pore waters of the Skonun sedimentary rocks are a likely source of mineralizing fluids. The sedimentary host rocks at Cinola are of fluviatile origin and therefore pore waters should have low NaCl and CO_2 content which is consistent with the fluid inclusions data.

Open-space filling textures and the absence of coexisting vapour-dominated inclusions at Cinola suggest either that boiling did not occur or that the boiling 'top' of the system has been removed by erosion. For maximum filling temperatures of 300 degrees celsius and a salinity of 0.4 per cent NaCl equivalent solution, a hydrostatic pressure equivalent to a depth of 1 100 metres below surface is necessary to prevent the system from boiling (Haas, 1971). This depth is considered a minimum for mineral deposition in that part of the Cinola system available for study because of the absence of boiling. Based on the total maximum thickness of the overlying stratigraphic section to the east (Sutherland Brown, 1968) the maximum possible depth of mineralization appears to be 1 800 metres.

Clathration, observed in two samples, indicates the presence of small amounts of CO_2 and it is possible that a very small amount of CO_2 also occurs in inclusions where clathration was not recognized. The Skonun

Formation is a plausible source for this CO_2. Local shell-rich layers are a characteristic feature of the Skonun Formation and are well exposed at the type locality at Skonun Point on the north shore of Graham Island (Sutherland Brown, 1968). Thin zones of Skonun sandstones and conglomerates are cemented by calcite for as much as 30 centimetres from shell-rich layers that are normally only a few centimetres wide. Similar shell-rich layers occur in drill core at the Cinola deposit (Champigny and Sinclair, 1980).

CONCLUSIONS

Although these fluid inclusion studies are not comprehensive they provide important constraints on a genetic model for the Cinola deposit. The low salinities and low CO_2 content of the ore fluid are consistent with the suggestion that the fluid originated as pore water in the fluviatile Skonun Formation. Filling temperatures, and the absence of textures resulting from boiling, suggest a minimum depth of formation of about 1 100 metres and stratigraphic information suggests a maximum depth of formation of about 1 800 metres.

The two major peaks of filling temperatures suggest that two principal temperature regimes existed during the depositional history. These peaks indicate an early period of high temperature deposition and a late period of lower temperature deposition.

ACKNOWLEDGMENTS

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