EXPLORATION FOR GOLD AT PINE CREEK AND TENNANT CREEK, N.T. AND AT HALLS CREEK, W.A. USING THE FLUID INCLUSION DECREPITATION TECHNIQUE

By

K. BURLINSON[1]

EXTENDED ABSTRACT

The decrepitation technique is a rapid means of measuring abundances, temperatures and to some extent the fluid compositions, of fluid inclusions in transparent and opaque minerals. The method has been used to investigate the hydrothermal fluid systems associated with gold mineralisation in the Tennant Creek, Pine Creek and Halls Creek Goldfields. At the Enterprise Mine, Pine Creek, several different stages of quartz veining are distinguished and within these, gradational changes in fluid temperatures and compositions help to define the centre and nature of the thermal system responsible for the mineralisation. In the surrounding Pine Creek region and at Tennant Creek and Halls Creek, the results were applied on a regional scale to characterize outcrops and aid in the discrimination between potentially mineralized and barren outcrops.

The decrepitation method involves the heating of a small (1gm) sample of crushed and sized grains up to as high as 800 degrees celsius. During the heating the fluid inclusions within the grains develop sufficient internal pressure to physically burst, the temperature of such bursting being dependent on the type of fluid and the prevailing temperature at the time the inclusion was originally trapped. The resulting tabulation of the number of inclusion bursts per 10 degree temperature interval is plotted as a histogram of decrepitations versus temperature and called a decrepigram. The decrepigrams frequently show several distinct peaks at different temperatures which are caused by different populations of inclusions in the sample. The areas of the peaks indicate the abundances of inclusions in each population while the shape and mean temperature of the peak provides a guide to the type of fluids involved. Of particular importance in this study is the presence of decrepitation peaks at fairly low temperatures (around 200° C. These are characteristic of CO_2 rich fluids which build up internal pressure very quickly when heated.

The Enterprise Gold Mine at Pine Creek comprises a number of overlapping quartz vein systems hosted by Burrell Creek Formation sediments. The geology of this mine has been described at this conference by Dann and Delaney, who have defined several distinct stages of quartz veining based on structural, mineralogical and physical features of the veins. For this decrepitation study, 19 quartz samples from the mine and environs, including some from each stage of veining were collected. These results suggest that there are 4 major vein types, within 3 of which additional small variations can be discerned which are due to gradational changes in the temperatures and fluid compositions in the mine area.

The pre-folding quartz veins are readily distinguishable both in hand specimen, where they are folded, and in the decrepigrams, which are bimodal and show only very low decrepitation activity (typically a maximum of 100 counts per 10° C. interval). Three additional groupings of quartz are apparent from the decrepigrams although it is not yet clear exactly how they relate to the geologically defined quartz stages. The second and third decrepitation groups also have bimodal decrepigrams, but these are markedly more active than the pre-folding veins and typically show a maximum of 1000 to 2000 counts per 10° C. interval. The group 2 samples have a decrepitation peak which begins at 370 °C whereas the group 3 samples have an equivalent peak at a markedly lower temperature (320° C.). In both groups some samples show unusually broad peaks which are tentatively interpreted as being due to boiling of the fluids (Fig. 1). The final group of samples is very different and these samples have trimodal decrepigrams. These all have a very low temperature peak in the vicinity of 200° C. which is due to the presence of CO_2 rich fluids in these quartz

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1. Principal,
Burlinson Geochemical Services Pty. Ltd.
DARWIN, N.T.

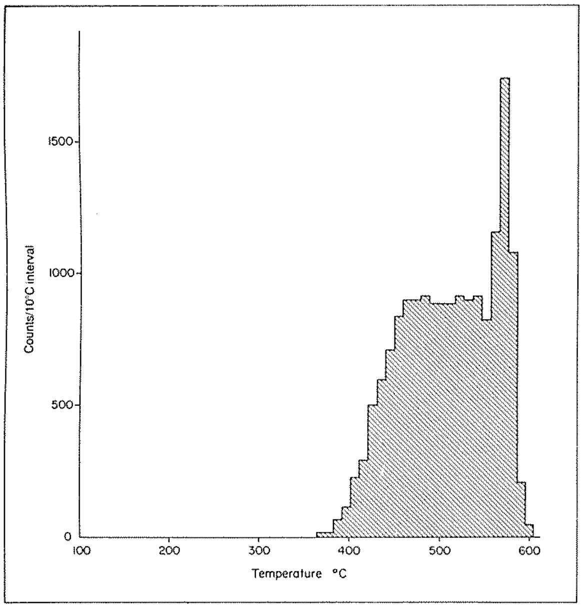

Fig. 1 Decrepigram of a group 2 quartz vein (no CO_2 from the Enterprise Mine, Pine Creek. The broad initial peak may indicate boiling)

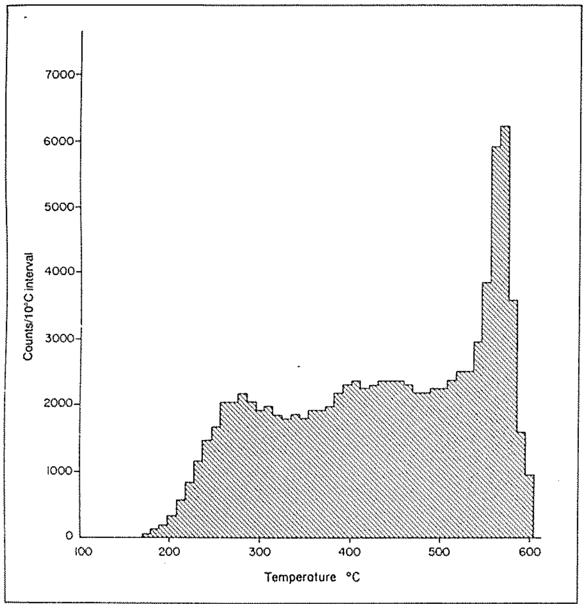

Fig. 2 Decrepigram of a group 4, CO_2 bearing quartz vein from the Enterprise Mine, Pine Creek.

veins (Fig. 2). Within this group the samples show significant variations in temperature of the middle peak which varies from 430^{o} C. to over 520^{o} C. and 3 distinct subgroups can be recognized.

The gold mineralisation occurs in veins belonging to both groups 2 and 4 although not all occurrences of these vein types are mineralized. The formation of a gold deposit requires both a suitable gold bearing fluid together with a depositional mechanism. At the Enterprise Mine, the decrepigrams can assist in defining which veins were formed from favourable fluid types although the lack of a depositional mechanism at the sampled locations may mean that the veins are locally unmineralized.

In association with the above sampling at the Enterprise Mine, 28 additional samples were collected from the Pine Creek area. 19 of these were from the Spring Hill and Yam Creek gold workings, the Jimmy's Knob tin workings and the Flora Belle lead workings, all of which are quartz vein systems with associated faulting. The remaining 9 samples were from various unworked barren quartz veins in the area. Of these 28 samples only seven had low temperature peaks due to CO_2 rich fluids, the remainder lacking any evidence of CO_2 . All of the samples from the Spring Hill workings showed intense low temperature peaks on the decrepigrams while the sample from the Yam Creek workings and two of the Jimmy's Knob samples have less intense low temperature peaks. Hence 6 of these CO_2 containing samples are closely associated with knownAu or Sn mineralisation. The seventh sample had an intense low temperature peak and is from an apparently unworked quartz vein, close to some present day alluvial workings. The prominent CO_2 peak in this sample, together with its location, indicates that this supposedly barren vein might instead be prospective for gold mineralisation.

Much (but not all) of the gold mineralisation in the Pine Creek Area is associated with CO_2 rich fluids. Because such fluids give rise to a very distinctive pattern in decrepigrams of quartz veins, the decrepitation method is a potentially useful tool in the regional evaluation of quartz veins in this area.

At Tennant Creek, gold and copper mineralisation occurs within magnetite-haematite lodes which are essentially free of quartz. The geology has been described by Large, 1975. The decrepitation method, unlike the microscopic fluid inclusion methods, can be used on these opaque minerals and a trial survey was done on 20 ironstone samples from surface outcrops and underground. Both the magnetite and haematite give good decrepitation responses with up to 2000 counts per 10 C. interval. The decrepigrams show marked differences between the various samples which cannot all be interpreted on this brief trial survey. However it is clearly possible to distinguish at least 2 classes of ironstone. The ironstone bodies at Juno and Gecko Mines and the Cat's Wiskers prospect show unimodal decrepigrams with a peak at 580 C., in contrast to the more typical bimodal and occasionally trimodal decrepigrams from the Warrego Mine and various other prospects. These results clearly show that the decrepitation method can be used on opaque minerals such as haematite and magnetite, both on fresh and weathered samples. The interesting variations between the samples in the Tennant Creek area suggest that the method might have application in the rapid discrimination of potentialy mineralised and barren ironstone bodies.

At Halls Creek, W.A., two different gold mineralisation styles occur within Archaean sediments and volcanics of the Biscay and Olympio Formations. The Ruby Queen Mine is on a conformable quartz vein in a strongly faulted area within Olympio Formation greywackes whereas at the Bradley West mine, gold mineralisation occurs within thin quartz veins which are usually perpendicular to the bedding, within an altered acid extrusive of the Biscay Formation.

Decrepitation analyses from these two mines confirm that these two styles of mineralisation are quite distinct. The Ruby Queen decrepigrams are bimodal with the first peak at about 420 C. whereas at Bradley West, the decrepigrams, which are also bimodal, have the first peak at 480 C. Using decrepigrams it has been possible to group the other workings in the Halls Creek area into either of these two mineralisation styles. Because the host rock at the Bradley Mine is poorly preserved, there has been some problem in the past in determining its nature and it had been thought to be an intrusive carrying disseminated gold. However the decrepigrams show that there is an abundance of fluid inclusions within the host rock near to the old workings. This indicates that the gold mineralisation is the result of a later hydrothermal event instead of being a syngenetically mineralised igneous unit, as unaltered igneous rocks typically give no decrepitation response. The poor state of preservation of this rock can thus be seen to be due to hydrothermal alteration as well as to modern weathering.

Fluid inclusion data obtained by the decrepitation method have led to a better understanding of the mineralisation styles at Halls Creek and assisted in the understanding of the mineralisation at the Enterprise Mine. The ability to use ironstones at Tennant Creek leads to the possibility of using decrepitation as an aid in distinguishing the various types of ironstone and their mineralisation potential. In the Pine Creek area, these results show that CO rich fluid systems are very frequently mineralised and decrepitation analyses of quartz veins are therefore proposed as a regional screening tool.

ACKNOWLEDGEMENTS

The author gratefully acknowledges the assistance and cooperation of Goldfields Exploration and Geopeko and thanks them for permission to publish these results. Thanks are also due to R.W.T. Wilkins and G. Hladky of C.S.I.R.O. Division of Mineralogy for their continued support.

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