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Messina copper-sulphide deposits revisited: Cathodoluminescence and fluid inclusion studies, Limpopo Province, South Africa

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Messina copper deposits are situated within the Central Zone of the Limpopo Mobile belt along the Messina fault that strikes to the northeast – southwest direction. The ore comprised primarily of chalcopyrite and bornite with minor chalcocite and pyrite [1],[2] and [3]. The current work focused on the cathodoluminescence and fluid inclusion studies of the mineralised samples from Campbell and Artonvilla copper deposits with a view to unpack the unresolved issues on the genesis of the deposits.

Cathodoluminescence microscopy, fluid inclusion petrography, microthermometry and Raman spectroscopy methods were used at the University of Göttingen in Germany. Cathodoluminescence investigation was applied using hot cathodoluminescence microscope HC3-LM in order to identify and characterize different types of minerals, their textures, internal structures and different mineral generations and interrelations. Quartz, calcite, apatite and prehnite minerals were identified. Quartz revealed two types of generations; Qtz 1 and Qtz 2. For example, idiomorphic and allotriomorphic quartz revealed Qtz 1 and Qtz 2 respectively. Apparently quartz 2 formed as a result of recrystallization of early formed quartz that displayed cryptocrystalline texture. Recrystallization of Qtz 1 was due to the incoming mineralised hydrothermal solution that also altered host rocks resulting in chloritization and alteration of apatite. Primary and secondary apatite displayed alteration process while veined calcite revealed late calcite cutting across earlier formed minerals. This is a common phenomenon in sulphide ore mineralisation as calcite generally marks the end of sulphide ore formation.

The study of fluid inclusion revealed four types of inclusions, viz. Type I - L-rich (L + V); Type II - V-rich (L + V); Type III – High salinity + daughter minerals (L + V + Halite + Calcite) and Type IV – Gas-rich (L + V + $Ch_4 \pm N_2$) with Type I being dominant followed by Type III. The presence of Type III fluid inclusions is an indication of association with ore mineralisation [4]. Homogenisation temperature (T_h) ranged from ~220 - 80°C, with salinity ranging from 0.2 – 27.5 NaCl wt%. The T-P diagram revealed that the earliest fluid inclusions in allotriomorphic vein quartz with Type IV (gas rich) fluid inclusions associated with veined ore, were formed at temperature range of ~200 – 315°C at a pressure of 1.4 – 2 kbar. This was followed by fluid inclusions (Type I) from quartz vein with prehnite associated with disseminated ore at temperature range of 130-235°C at the pressure range of 0.66-1.5 kbar. Later the fluid inclusions (Type I and Type II) in idiomorphic quartz associated with brecciated ore were formed at low temperature and pressure range of 115- 240°C and 0.65 -1.6 kbar. Both T_h and T-P estimation (~220°C) and (~315°C) are pointing towards mesothermal ore formation, although the process of ore formation continued to a much lower temperature (~80°C).

From the above investigation, it is evident that the Messina copper deposits were of hydrothermal mode of formation. Emplacement of the copper sulphide ore occurred at a moderate temperature range of about 220°C – 315°C. The study revealed the occurrence of two generations of quartz (Qtz 1

and Qtz 2). The earlier formed quartz was recrystallized as a result of the mixture of influx mineralised hydrothermal solution that resulted also in the alteration of the host rock.

References:

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