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The discovery of sulfide melt inclusions from UST quartz layers at the Qulong deposit in southern Tibet: Implications for the genesis of porphyry Cu deposit

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Qulong, the first large porphyry Cudeposit found inthe Gandese porphyry Cu belt in southernTibet so far, contains ~10.6 Mt Cu withaverage grade of 0.5%and ~0.5 Mt Mo with average of0.03%. We found 5-meter-thick unidirectional solidification textures (UST) layers in drill hole ZK001 of Qulong porphyry Cu deposit. The UST layersoccurin the contact zone between the ore-forming porphyry (P Porphyry) and the surrounding rock (Rongmucuola rock), but only withinthe ore-forming porphyry. The quartz layers of UST were nearly paralleled, with the width ranging 0.5mm to 0.5mm. The prismatic quartz grains of the UST quartz layers had the uniform pointing direction, towards the ore-forming porphyry intrusion center. The UST layers are cut by different type A-veins, including quartz, quartz-K feldspar, chalcopyrite-biotite±quartz, andquartz-molybdenite-K feldspar±chalcopyrite veins. Qulong UST were formed during the magma-hydrothermal transition stage, the forming temperature of UST quartz (calculated by Quartz-Ti geo-thermometer) was 760^{o}C~800^{o}C. Lots of spheroidal sulfides in the UST quartz layers have beenfound, some of them are in the shape of negative quartz crystal, suggesting they aresulfide inclusions. As the UST is a kind of early stage textures, it cannot avoid the influence of later hydrothermal events. In order to determine the sulfides that found in the UST quartz layers were primary magmatic sulfide melt inclusions or later hydrothermal sulfides, we took numbers of the cathodoluminescence (CL) photos. The detailed CL petrographic study indicated that sulfides found in UST quartz layers were not controlled by the micro-fractures in quartz grains, in other words, they were primary magmatic sulfides, considering their special shape (spheroidal or negative quartz crystal shape), we suggested that they were primary sulfide melt inclusions. Furthermore, the trace elements characteristics (detected by situ LA-ICP-MS method)of the sulfide melt inclusions and hydrothermal sulfides showed a big difference, so we ensured they were primary sulfide melt inclusions. The discovery of sulfide melt inclusions in UST quartz layers indicated that the sulfur in the magma chamber was saturated, abundant metals preferred to migrate into sulfide melt then silicate melt. Later magmatic or hydrothermal events reactivated the sulfide melt forming the S-rich and metals-rich ore-forming fluids, then the ore-forming fluids precipitated at suitable position formed the porphyry Cu deposit precipitated. Some survived sulfide melt was not dissolved, instead, was captured into quartz grains of UST layers as inclusions. Therefore we conclude sulfide saturation, in other words, sulfide pre-enrichment in magma chamber is the key factor to form the giant Qulong porphyry Cu deposit, which explains the huge amount of sulfate and the phenomenon of sulfate throughout the whole process of mineralization.