New Constraints on the Formation of the Bolcana Au-Cu Porphyry System (Apuseni Mountains, Romania)

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The inferred resource of the Bolcana Au-Cu porphyry deposit (Apuseni Mountains, Romania) has recently been estimated to 381 Mt at 0.53 g t^{-1} Au and 0.18% Cu, containing 6.5 Moz of Au and 686,000 t of Cu. Here, we build on extensive drillcore logging and petrography to describe the Bolcana porphyry system along a continuous profile down to ~2 km depth. We track the magmatic evolution using zircon U-Pb and trace-element data, and show that the bulk of Au-Cu mineralization in Bolcana occurred at low temperatures (<410 °C) in the waning stages of the magmatic-hydrothermal system.

We group the calc-alkaline magmatism in Bolcana into three stages: dacite porphyry (stage I) first intruded at ~13 Ma, and ore-related, andesitic stage–II and stage–III porphyries followed at ~11 Ma. Despite their overlapping LA-ICP-MS and TIMS zircon dates, field evidences unambiguously demonstrate that stage–III porphyries intruded the previous lithologies in the form of narrow dikes, causing widespread brecciation while the hydrothermal system was still active. Trace-element composition of zircons from ore-related porphyries suggest their crystallization in the presence of apatite and hornblende, over a temperature span between ~675–950 °C.

Veining comprises quartz veins of A, AB, B, and banded ("Maricunga") style, C and D veins, and three types of magnetite veins. Sulphide ore minerals are, present in interstices in quartz veins and hostrocks as well as in sulphide-only C veins, and all texturally post-date quartz precipitation. Ti-in-quartz and fluid inclusion microthermometry constrain quartz precipitation to a continuous temperature range from 410–530 °C and 500–700 °C, respectively, implying that the sulphides were precipitated at even lower temperatures. Vein quartz in all stages precipitated from a purely magmatic fluid ($\delta^{18}O$=7.6–8.9‰). The predominance of low-density fluid inclusions within different quartz vein types suggests that quartz vein formation predating sulphide precipitation likely occurred under low pressures.