Magmatic-hydrothermal ore-forming systems: products of resurgent boiling, fluid focusing, and changing PTX conditions

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High-level magmatic-hydrothermal ore systems cover a large range in terms of the progenitor magma, tectonic setting, and metal endowment (e.g., Cu, Mo, Sn, W, Au, rare metals). However, all these ore systems share a common feature, this being they are the end product of ore metal precipitation from fluids generated due to volatile saturation of evolving melts through the processes of first and second, or resurgent boiling. This latter stage of magma evolution is critical to ore-deposit formation since it is the vehicle by which metals are transferred from a metal-rich melt to a fluid under conditions of favourable elemental partitioning (i.e., $KD^{fluid/melt} > 1$). The preservation of both melt and fluid inclusions in, for example, miarolitic cavities provides direct evidence of this process and confirmation of fluid-metal enrichment. The subsequent focusing of this metal-rich fluid into sites undergoing transient changes in PTX leads to metal precipitation; a variety of mechanisms are possible, such as fluid:rock interaction (e.g., greisens, skarns) or fluid mixing or unmixing. In this presentation, a range of textures (e.g., miaroles, stockscheiders, USTs, breccias) preserved in samples from a variety of ore settings are used to illustrate these important ore-forming processes, commencing with melt saturation and fluid exsolution, which can be either passive or catastrophic depending on the ΔP, through fluid focusing and ore formation. In order to illustrate these processes in further detail, two case studies are used: (1) the 380 Ma East Kemptville greisenhosted Sn-Cu-Zn-Ag deposit which is related to the extreme fractionation of a F-rich and volatile charged felsic magma that, due to second boiling, generated a metal-rich mineralizing fluid. This fluid was subsequently focused along the faulted contact between topaz leucogranite and sediment where greisen formation controlled cassiterite precipitation; and (2) the Cretaceous Mongolian topaz ongonites that which are spatially associated with raremetal mineralization. These topaz-two feldspar dike rocks record preservation of primary igneous textures and have been considered by some as pristine examples of metaland F-rich felsic melts. However, detailed mineralogical and isotopic studies indicate these rocks record a pervasive metasomatic event due to reaction at high temperature (ca. 400°C) with fluids of both magmatic and meteoric origin. The latter observations suggest some rare-metal enrichment in evolved felsic rocks, such as the ongonites, is secondary rather than primary magmatic, as considered by many, which has implications for genetic models for these systems.

Atlantic Geology, 2015, Volume 51, Number 1
41st Colloquium & Annual General Meeting 2015
doi: 10.4138/atlgeol.2015.005