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Constraining timescales of ore-formation by numerical simulations of magmatic-hydrothermal systems

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Fluid flow in magmatic-hydrothermal systems is strongly influenced by the properties of salt water. Within the pressure and temperature range of most ore-forming geological settings these vary non-linearly by orders of magnitude, and fluids can phase separate [1]. This complexity can have a large impact on fluid evolution and migration and, consequently, on timescales of ore-forming systems. Capturing these non-linearities is challenging for any modelling approach and numerical simulations often use simplifying assumptions. However, recent studies implementing more realistic fluid properties have demonstrated their immediate impact on the transient behaviour of magmatic-hydrothermal systems [2,3]. Mid-ocean-ridge systems have been shown to develop into a mass and energy flux optimizing interplay of up- and downflow and an efficient metal-leaching process that might be able to form a massive sulfide deposit in less than 10^3 years [4].

Silicic magmas carry several percents of volatiles which are released upon crystallization or depressurization. Our modelling approaches of subduction-related ore-forming systems depend on conceptual models prescribing magma emplacement, fluid exsolution from magmas and its injection into vein systems. First simulations constrain the timescale of a single magmatic event assuming a stagnant magma chamber exsolving fluid by crystallization to 10^4 to 10^5 years. Initial simulations assuming higher fluid injection rates from an inferred convecting chamber might confirm an expulsive behaviour, as recently discussed for the timescale of alteration and ore deposition of less than 10^3 years [5]. These generic simulations will be followed by site-specific studies on the Bingham Canyon porphyry deposit [6] and the active submarine system at Brothers volcano [7].

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