Estimates of the amount of time required to form an epithermal precious metal deposit based on ore grade & tonnage, fluid flow rate, and metal content of ore fluids

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One of the least understood aspects of ore genesis concerns the duration of the mineralizing event. We have used ore tonnage (production + reserves) and grade information along with observed fluid flow rates in active geothermal systems to estimate the amount of time required to form an epithermal Au-Ag deposit. Total gold tonnage for 279 epithermal veins and deposits ranges from 0.0002 T (6t oz; Wharekirau- ponga, NZ) to 2,170 T (69 x 10^6 t oz; Yanacocha, Peru), with an average of 4.1 T. Total silver tonnage for 252 epithermal deposits ranges from 0.0004 T (12t oz; Wharekirau- ponga, NZ) to 62,207 T (2.0 billion t oz; Cerro Rico de Potosi, Bolivia), with an average of 60.3 T (1.94 million t oz). The average gold grade, based on 241 deposits, is 4.4 g/T, and the average silver grade is 88 g/T. Reported flow rates for 695 active continental geothermal systems and hot springs average 6.0 kg/sec. Assuming a gold content in the ore-forming fluid of 1.8 μg/kg (1.8 ppb), the amount of time required to deposit the average amount of Au estimated for epithermal deposits is 7,940 yr, with 68% (one standard deviation) of the deposits requiring between 132 and 479,000 yr to form. Assuming a silver content in the ore-forming fluid of 33.9 μg/kg (33.9 ppb), the amount of time required to deposit the average amount of Ag estimated for epithermal deposits is 9,330 yr, with 68% of the deposits between 120 and 724,000 yr.

Results of this assessment indicate that the duration of active mineralization in epithermal systems need not be longer than ~10^4 yr, assuming continuous deposition. Field and laboratory data suggest, however, that mineralization is not continuous but, rather, is episodic and associated with discrete hydrothermal eruption events that lead to boiling and the quantitative precipitation of all metal in solution. As such, gold and/or silver deposition is likely occurring over only a small fraction of the total lifetime of the hydrothermal system. Results of this study also suggest that formation of giant deposits in a geologically reasonable amount of time requires hydrothermal systems that were active for longer periods of time and were characterized by higher fluid flow rates.