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ARTICLE

New $^{40}Ar/^{39}Ar$ alunite ages from the Colquijirca district, Peru: evidence of a long period of magmatic SO_2 degassing during formation of epithermal Au–Ag and Cordilleran polymetallic ores

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Abstract We present $^{40}Ar/^{39}Ar$ data acquired by infra-red (CO_2) laser step-heating of alunite crystals from the large Miocene Colquijirca district in central Peru. Combined with previously published data, our results show that a long (at least 1.3 My) and complex period of magmatic-hydrothermal activity associated with epithermal Au–(Ag) mineralization and base metal, Cordilleran ores took place at Colquijirca. The new data indicate that incursion of magmatic SO_2-bearing vapor into the Colquijirca epithermal system began at least as early as ~11.9 Ma and lasted until ~10.6 Ma. Four alunite samples associated with high-sulfidation epithermal Au–(Ag) ore gave $^{40}Ar/^{39}Ar$ plateau ages between ~11.9 and ~11.1 Ma (compared to the previously documented ~11.6 to ~11.3 Ma). By combining individually these new ages with crosscutting relationships, the duration of the Au–(Ag) deposition period can be estimated to at least 0.4 My. Three new $^{40}Ar/^{39}Ar$ plateau ages on alunite associated with the base-metal Cordilleran ores are consistent with previously obtained ages, all of them between 10.83±0.06 and 10.56± 0.06 Ma, suggesting that most of the sulfide-rich polymetallic deposits of Smelter and Colquijirca formed during this short period. The recognition of consecutive alunite-bearing and alunite-free mineral assemblages within both the Au–(Ag) and the base-metal Cordilleran ores may suggest that SO_2-bearing magmatic vapor entered the epithermal environment as multiple discontinuous pulses, a number of which was not necessarily associated in time with ore fluids. It is likely that a period of SO_2-bearing vapor degassing longer than 11.9 to 10.6 Ma may be recognized with further more detailed work.

Keywords Epithermal · Alunite · High sulfidation · $^{40}Ar/^{39}Ar$ geochronology · Cordilleran · Colquijirca · Peru

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Introduction

Hydrothermal systems with life spans over 1 My have been documented for several major porphyry-related systems, including Chuquicamata, El Teniente, Butte, La Escondida, and Cerro de Pasco (Ossandón et al. 2001; Gustafson et al. 2001; Pécskay snd Molnár 2002; Heather et al. 2003; Maksaev et al. 2003; Baumgartner et al. 2006; Baumgartner 2007). Several studies propose that long hydrothermal life spans are the result of multiple pulses related to each one of the single intrusions and which should not exceed durations on the order of 50–100 ky (e.g., Marsh et al. 1997; Henry