

First U-Pb LA-ICP-MS *in situ* dating of supergene copper mineralization: Case study in Chuquicamata mining district, Atacama Desert, Chile

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Since the second half of the 20th century, exotic copper mineralization represents a prime target for many of the mining exploration companies operating in the hyperarid Atacama Desert, in northern Chile. Although there is evidence that the emplacement of such deposits took place during specific Tertiary climatic periods and relief formation, many uncertainties remain regarding the exact timing for their deposition and/or the genetic link between the exotic deposits and the primary porphyry copper deposits. We present a first attempt of U-Pb dating of copper-rich minerals from the Mina Sur exotic deposit from the Chuquicamata mining district. A suite of Mn-rich black chrysocolla clasts surrounded by pseudomalachite layers has been characterized and dated in context using both nanosecond and femtosecond *in-situ* laser ablation ICP-MS analyses. U-Pb dating performed on pseudomalachite beds yields a crystallisation age of 18.4 ± 1.5 Ma. For the Mn-rich chrysocollas clasts, the $^{206}\text{Pb}/^{238}\text{U}$ apparent ages range from 17.5 ± 0.2 Ma down to 5.8 ± 0.1 Ma, a spreading interpreted as the result of U and/or Pb mobility linked to fluid circulation following crystallization. This study demonstrates, for the first time, that supergene copper mineralization presents a chronological potential and can be dated, at least in some case, by the U-Th-Pb method. Furthermore, the age obtained on pseudomalachite indicates that Mina Sur deposition took place at ca. 19 Ma, about 12 Ma after the unroofing and hydrothermal alteration of the Chuquicamata deposit, a result that is consistent with the supergene ages already known in the Atacama Desert. These promising results represent a new tool for the understanding of the physico-chemical, climatic and geological conditions that prevailing during the formation of exotic deposits and a proxy for their exploration in Chile and elsewhere in the World.