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Geomorphological and climatic constraints on the supergene processes in the Atacama Desert

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Geomorphological and climatic conditions enhancing supergene mineralization and enrichment of metalliferous ore deposits are being studied in many arid region through the world. We present a summary of the work carry out on two contrasting mining district of the Atacama Desert: the Centinela District (CD), in the hyper-arid desert core, and the Salvador-La Coya District (SCD), in the southern desert border. In both, well developed supergene mineralization zones are distributed on peneplain surfaces and are formed during landscape peneplanation. In the CD, landscape paneplanation occurs between the Oligocene and the mid-Miocene whereas the supergene mineral ages indicate that supergene processes occurs between 25–12 Ma. In the SCD, the timing of supergene processes depends on where the supergene mineralization is exposed. In the western Precordillera piedmont, the Salvador porphyry-Cu undergo protracted supergene enrichment and exotic mineralization, which can be tied to multiple stages of pediment incision taking place episodically since the late Eocene through the mid Miocene. In contrast, supergene mineralization in the high Precordillera is hosted below a planar late Oligocene peneplain relict and supergene mineralization is restricted between the late Oligocene and early Miocene. Supergene mineral ages of the CD define two supergene episodes (25–19 and 15–12 Ma), during which most of the supergene ages cluster in the hyper-arid desert core. Relatively wet, weathering-prone climate conditions, alternate with relatively dry conditions during the early Miocene and can explain major peaks in the distribution of supergene ages from many areas of the southern hemisphere. Gaps in supergene ages can be related to drier conditions which limits supergene processes, as occurs with the onset of hyper-aridity after the mid-Miocene. In the SCD, supergene ages other than early Eocene probably results from wetter climate conditions prevailing through most of the late Cenozoic in the southern desert border. We conclude that landscape pediplanation favours supergene mineralization and helps preserve the former supergene mineralized zones from significant erosion. Low erosion rates during pediplanation may constitute a necessary condition for the efficiency of the supergene processes. Such a favourable geomorphologic condition also requires a relatively wetter climate condition to allow the supergene processes to occur.