14.7±0.6 and 27.3±0.3 Ma, while Mn-oxides have ages from 9.8±0.8 to 14.0±0.3 Ma. Figure 2 shows the relation between best age estimation of supergene minerals and elevation for twenty samples. A probability diagram, which contains K-Ar and $^{40}Ar/^{39}Ar$ ages of both supergene alunite and Mn-oxide minerals, is shown in Figure 3. Results suggest that supergene minerals precipitated between *ca.* 33 and 9 Ma and two significant changes in geological and environmental conditions were recorded at 14 Ma and 9 Ma, when alunite and Mn-oxide precipitation ended.

Discussion and Conclusions

Supergene mineral precipitation ages suggest that supergene oxidation in Central Depression at 25°S was product of long-term weathering extending from the Oligocene to Upper Miocene. The abrupt end of supergene alunite generation at 14 Ma is similar to observed by previous studies in porphyry copper deposits in Precordillera of Northern Chile (Sillitoe and Mc Kee, 1996; Alpers and Brimhall, 1988; Bouzari and Clark, 2002). On the other hand, favourable conditions for the precipitation of Mn-oxides in the studied area, only existed after 14 Ma., and prevailed at least until 9 Ma. End of alunite precipitation was probably related to complete pyrite oxidation, whereas end of Mn-oxides production would document the end of humid conditions.

Most obtained ages suggest a general simplest inverted age profiles, where the first weathered, older assemblage is present at the upper parts of the profile, while more recently oxidized rocks are present in the lower parts of the profile (Fig. 2). Although some samples were displaced by field observed faulting, the broadly horizontal downward migrating weathering front, suggest be related to a general descending water table and deeping of the supergene profile through the Miocene in Northern Chile.

Ages in this study suggest that supergene minerals formation appears to be associated with discrete events rather than continuous mineral generation. Alunite generation is defined by a minor pulse at ~33 Ma and five more significant periods at 27, 25, 22-23, 16-19, and 14-15 Ma, whereas Mn-oxides occurred at 14, 12, and 9-10 Ma pulses. Discrete generation events appear related to tectonic pulses that produces surface uplift by local crustal shortening or by regional tilting. Tectonic activity for these periods has been documented (e.g. Sébrier et al., 1988; McKee and Noble, 1989) and is consistent with supergene mineral precipitation events. Surface uplift provides erosion and downward movement of water table favouring supergene minerals precipitation and pedimentation process. The end of main period of regional pedimentation in Northern Chile (9 Ma) occurred at same time of supergene minerals cease. The moderate precipitation inferred for supergene mineral generation in Atacama Desert suggest a prevalence of semi-arid conditions at least until 9 Ma, or exceptional climatic disturbances that permit humidity transfer across the Andes from Amazons basin into an hyperarid Atacama region (Zachos et al, 2001). The combination of both sporadic wetter periods and surface uplift/erosion, may have controlled the generation of Miocene supergene alunite and Mn-oxides in the Atacama Desert of Northern Chile.

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