Sources and sinks of iodine in the Atacama Desert, northern Chile: Insights from the nitrate ore fields and supergene zones of Cu deposits

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Iodine is a strongly biophilic element and its global distribution is dominated by the marine system, in particular marine sediments. Because iodine is rarely incorporated into minerals, the occurrence of iodine minerals in continental settings is rare, with the exception of hyperarid areas such as the Atacama Desert of northern Chile. Currently, the Atacama region is the world's premier iodine production province, where the occurrence of iodine minerals is exclusively restricted to: (a) The extensive nitrate-iodine deposits located along the eastern side of the Coastal Range, and (b) The supergene zones of Cu deposits. The presence of iodine in copper and nitrate deposits is enigmatic and has been seriously underlooked over the years. Little information is available about the source (s) of iodine in the Atacama region, and only a few studies have reported data on the mineralogy, geochemistry and isotopic composition of iodine in these deposits.

Preliminary iodine-129 (^{129}I) data of nitrate ores of the Atacama Desert show that the isotopic signature of this element in the nitrates is not consistent with a marine fog origin, as previously thought. These low $^{129}I/I$ ratios, comprised between 75 and 200×10^{-15}, are similar to previously reported ratios of forearc fluids, suggesting that the iodine component of nitrate deposits may have a different origin than atmospheric or marine (e.g. deep source). Moreover, the occurrence of iodine minerals in supergene zones of copper deposits nearby (e.g. the stratabound Cu deposit Mantos de la Luna) indicate that reducing iodine-rich waters were involved in supergene enrichment of copper. In the light of these new evidences, alternative source(s) for the iodine that is contained in copper and nitrate deposits in the Atacama Desert are presented. This information is of utmost importance to better understand the processes that have led to iodine enrichment in northern Chile, and its relation with the tectonic/seismic/metallogenic history of the area and changes in climate, particularly the desiccation of the Atacama region.

Orogen-scale thermochronologic trends of the Central Andes

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The central Andes between ~21-28°S record Mesozoic to Recent evolution of arc magmatism and development of an associated 700-km-wide Cordilleran style retro-arc wedge formed by east-directed thrusting of the orogen over the South American plate. Several features of this region have attracted attention of wedgeologists, including: 1) an extreme orographic precipitation gradient (~zero on the west flank) that may influence deformation patterns, 2) evidence for punctuated episodes or cycles of uplift potentially linked to lithospheric convective instability, and 3) extension and subduction erosion at the western pro-arc side of the orogen.

To better constrain the large-scale dynamics of this part of the Andes, we combine apatite and zircon (U-Th)/He and FT ages from ~30 new samples with published data to create several cross-orogen transects recording bedrock cooling between ~21-26°S. All systems show decreasing ranges of cooling ages and increasing minimum ages from east to west across the range: zircon He from ~15-385 Ma in the east to ~120 Ma in the west, apatite FT from ~15-200 Ma in the east to ~45-100 Ma in the west, and apatite He from ~5-50 Ma in the east to ~35-60 Ma in the west. Just to the south (~26-28°S), AFT ages are 3-180 Ma in the east to ~45 Ma in the west. We interpret these trends with a simple model of frontal accretion and relative westward motion of rocks through an eroding (stationary and steady-state) wedge. Although the model has too many free parameters to uniquely constrain detailed dynamics, it provides several insights into the significance of thermochronologic trends at this scale. The overall form of most of these data is consistent with erosion at ~0.5-0.7 mm/yr within only a ~100-km wide region on the east flank; to the west rocks are advected through a non-eroding wedge at roughly 6 mm/yr to decretion at the Pacific margin. Only locally on the east flank is cumulative erosion high enough to expose fully reset zircon He ages. Younger apatite He ages within the range interior require localized and possibly punctuated episodes of erosion to depths <~2 km. To the south, AFT age trends require more rapid erosion (~1 mm/yr) focused in a narrower eastern zone (~50 km), and predict the presence of very young apatite He ages but few to no reset zircon He ages.