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Species-dependent Nutrient Uptake in Plants of the World's Driest Desert (Atacama) constrained by Trace Elements and Sr Isotopes

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The Atacama Desert in Chile, the driest non-polar desert on Earth, provides an exceptional natural habitat for investigating nutrient acquisition strategies of plants. The endemic desert shrubs *Huidobria chilensis* and *Prosa fruticosa* (Loasaceae) were selected for this study. The species are geographically separated by the ten mm/yr isohyet crossing the Atacama Desert. P. *fruticosa* receives less than ten mm/yr precipitation, while *H. chilensis* experiences more. We determined $^{87}Sr/^{86}Sr$ isotope ratios together with major and trace elements (e.g., Na, P, Ca, REEs) in plant tissues and associated soils. Our results show that both desert shrubs exhibit Sr isotope signatures distinct from those of the bulk soils, indicating selective nutrient uptake from specific mineral phases. To characterize the isotopic and elemental composition of these phases, we applied a sequential leaching protocol to representative soil samples. First, water-soluble minerals were dissolved. Using an ion exchange resin, sulfates were selectively dissolved under pH-neutral conditions. Phosphates and similar compounds were attacked with HCl, followed by the complete digestion of the remaining silicate matrix in HF-HNO_3 [1].

H. chilensis exhibits Sr isotope compositions nearly identical to those of the water-soluble salt and sulfate fractions, although these only contribute 4-10 wt.% to the soils' mass. This suggests that soluble salt and Ca-sulfate phases are the primary nutrient sources. The soils of *P. fruticosa* consist of up to 20 wt.% of salts and sulfates, yet plant tissue Sr signatures differ from these fractions. *P. fruticosa* displays isotopic signatures that can not be explained by the nutrient uptake from a single leached fraction, suggesting a more complex integration of multiple mineral phases, including phosphates and silicates. Relative to the bulk soil, both plant species display negative Eu and Ce anomalies, overall reflecting the control of soil pH and EH on adsorption mechanisms of minerals [2]. We speculate that the higher precipitation rate may have enhanced the bioavailability of salts and sulfates for *H. chilensis*. Under drier conditions, these phases become less accessible, preventing *P. fruticosa* from effectively acquiring nutrients from these sources alone.

[1] Deußen et al., 2025, Chemical Geology, 692
[2] Durães et al., 2014, Planetary Science, 10