Paleoaltimetry of the southern Andes: limits to interpreting isotope data in a rain shadow

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As part of a large-scale paleoclimate study, oxygen isotope data were collected from fossil teeth from Eocene to Miocene strata at Gran Barranca, Argentina (~46° S lat.) in the rainshadow of the southern Andes. These data highlight the importance of identifying water sources prior to interpreting elevation histories from $\delta^{18}O$ data. Biogenic fractionations are retained by PO_4 and CO_3 components, suggesting an absence of diagenetic alteration. These data show nearly constant compositions of ~16‰ for PO_4 at 39-30 Ma, a ~2‰ drop to ~14‰ at 27 Ma, and a ~1‰ rebound to ~15‰ at 20 Ma. Fossil teeth that are 12 Ma from ~100 km to the SW have compositions ~0.5‰ depleted relative to 20 Ma teeth.

Because compositions deviate from models that incorporate global paleoclimate, they could be interpreted in terms of elevation increases and decreases. Modern precipitation shows a ~4‰ decrease in $\delta^{18}O$ over ~1500 meters mean elevation, and tooth enamel tracks precipitation with a correction factor of ~0.85. Thus tooth $\delta^{18}O$ changes could imply elevation changes of +900 meters between 30 and 27 Ma, -450 meters by 20 Ma, and +200 meters by 12 Ma to reach quasi-modern heights.

However, these interpretations ignore regional sources of water, including a marine seaway that periodically flooded the lee of the Andes in the region. In fact, major highstands at 29-40 and 13-24 Ma correspond to higher $\delta^{18}O$ values, whereas lowstands at 24-29 and 0-13 Ma correspond with lower values. One simple interpretation is that the southern Andes had already reached quasi-modern heights by 39 Ma, and that local precipitation in the "rainshadow" was sourced by the proximal seaway during transgressions and the Pacific Ocean during regressions.