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Living on the edge: The oxygen isotope record of Eocene Basins at the margin of the Cenozoic North American plateau

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Topography has a strong impact on atmospheric circulation and precipitation patterns and is a key element in reconstructing the dynamics of mountain building processes. The topographic evolution of the world's major orogens remains one of the most important questions when discussing the interactions among tectonics, climate, and Earth surface processes. Here, we focus on the spatial and temporal development of topography and relief in the western North American Cordillera and how changes in the topography may have affected precipitation patterns and vice versa.
In this context, we sampled more than 20 sections in Eocene to Oligocene terrestrial (intermontane?) basins (Chumstick, Swauk, and Chuckanut) in western and central Washington (USA) to the W and E of the modern Cascades. Oxygen isotope analysis of pedogenic carbonate in these sections allows us to reconstruct the isotopic composition of ancient soilwater or groundwater, and ultimately precipitation.
Oxygen isotope measurements of pedogenic concretions and calcic horizons interestingly yield uniformly low δ18O values of 10 to 13‰ SMOW despite the proximity of all sections to the Pacific moisture source. These extremely low oxygen isotope values can result from (1) highly 18O-depleted meteoric waters (soil- or groundwater), (2) burial diagenesis at moderate temperatures and interaction with 18O-depleted (ground)water, and (3) high burial temperatures and and exchange with basins brines. Vitrinite reflectance data and preservation of primary soil structures such as rootlets, root casts, burrows, or even preserved wood fragments clearly show that some of the low-d18O sections were not affected by high degrees of burial diagenesis. Thus, we believe that the primary isotopic signal of ancient soil- or groundwater is preserved at least in parts (if not in all) of these basins. Low δ18O values of pedogenic carbonate require highly 18O-depleted meteoric water, which in turn, would require high elevation either at the site or within close proximity. However, paleofloral data from e.g. the Chumstick basin to the E of the modern Cascades indicate moderate elevations and montane rain forest conditions during a warm (MAT = 14°C) and rather wet, seasonal Eocene climate. Therefore, we tentatively suggest that these basins were at moderate elevations, allowing dense vegetation and seasonal drying of soils, but were fed by isotopically highly 18O-depleted runoff and groundwater from elevated catchment areas in the vicinity of the basins. This requires Eocene highlands of the North American Cordillera to be laterally extensive already during the Eocene and places important constraints on the impact of the plateau region on atmospheric circulation patterns.