

EGU22-2346

<https://doi.org/10.5194/egusphere-egu22-2346>

EGU General Assembly 2022

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Early-Miocene stable isotope paleoaltimetry estimates for the Central Alps

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Quantifying surface elevation over geological time is essential for reconstructing coupled climatic and mountain building processes. Surface uplift of an orogen, such as the European Alps, results from the interplay between subsurface geodynamic processes and climate-induced denudation. Although being one of the most studied mountain ranges worldwide, knowledge about the elevation history of the European Alps is still scarce. Stable isotope paleoaltimetry is a robust tool to reconstruct paleoelevations of orogens. The method is based on the systematic inverse relationship of isotope ratios of oxygen ($\delta^{18}\text{O}$) and hydrogen (δD) in precipitation with elevation. Recent stable isotope paleoaltimetry studies that focused on the Central Alps indicate elevations locally exceeding 4 km during the Mid-Miocene. Here, we reconstruct past Alpine surface elevations by applying stable isotope paleoaltimetry coupled with clumped isotope, $T(\Delta_{47})$, temperature reconstructions in Miocene paleosols of the Alpine foreland basins. Knowledge of low-elevation (near sea level) temperature conditions allows to refine low-elevation, near sea level estimates for $\delta^{18}\text{O}$ in precipitation. Contrasting these low-elevation isotope in precipitation values with age equivalent records from high elevation counterparts hence permits calculation of surface elevation differences between the foreland basin and the orogen interior. With a spatio-temporally enhanced coverage of the European Alps, we present a long-term terrestrial climate record covering the time interval between ca. 23 and 14 Ma including sites in the Western and Central Alps. Pedogenic carbonate nodules from paleosols of the Digne-Valensole basin (Western Alps, France) indicate relatively warm and stable temperatures (ca. 26°C) for the early Miocene (23-20 Ma) followed by enhanced temperature variability with maximum values of 34°C at ca. 16.5 Ma. By contrasting temperature-corrected foreland basin pedogenic carbonate $\delta^{18}\text{O}$ values from the Digne-Valensole Basin with δD values of dated, clay-bearing fault gouge from the Periadriatic Fault in Val Morobbia (Switzerland), we conclude that the stable isotope paleoaltimetry data permit peak elevations of 4-5 km in the Central Alps during the earliest Miocene (ca. 23 Ma).

References

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