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# Geologically-recent uplift of the central Apennines through slab breakoff: Stable isotope and thermochronology evidence

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Estimates of surface uplift and exhumation are necessary to reconstruct the evolution of mountain belts and quantify the contributions of shallow and deep processes to the underlying geodynamics. We focus on the Central Apennines, which formed as an accretionary wedge before undergoing post-orogenic extension. Since 3 Ma, it overlies an area of local slab detachment. We aim to better relate surface observations to possible geodynamic processes. To do so, we combine low-temperature thermochronology to date exhumation and stable isotope paleoaltimetry to reconstruct surface topography, with samples collected from 13 intermontane basins in the central Apennines that record both tectonic and climatic syn-orogenic events. Today, meteoric waters in the Apennines show progressively lower $\delta^{18}$O with elevation, with an approximately 5‰ difference between sea-level and high-elevation sampling sites, suggesting that authigenic carbonates in these basins may preserve a measureable difference between sea-level and high-elevation localities.

Our 34 new apatite (U-Th)/He ages from Miocene sandstones range from 7 Ma on the Thyrrenean coast to 1.62 Ma in the Central-Eastern Apennines. This pattern reflects migrating extension due to Thyrrenian rifting, as well as a large scale uplift pulse around 2 Ma (exhumation rates $>$1mm/yr). We also present $>$500 lacustrine and paleosol carbonate $\delta^{18}$O measurements collected from various elevations along the mountain range. Since the Pliocene, the gradient in $\delta^{18}$O between basins near sea-level today and those at high-elevation today has continuously increased. We attribute this shift to increased orographic rainout, thereby causing progressively lower $\delta^{18}$O in high-elevation basins as they are uplifted. Using this data and the modern meteoric water $\delta^{18}$O lapse rate, we estimate that there has been approximately 1 km of uplift since late Pliocene. Both our isotopic data and exhumation ages match the suggested timing and expected amplitude of slab break-off. This supports the hypothesis that the opening of the Adriatic slab window caused substantial uplift in the area.