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Evolution of Shallow Isotherms Under Dynamic 3D Topography and Sampling Strategies for U-Th/He Dating: Examples From the Appalachian Blue Ridge and Southeastern Tibet

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AB The effects of erosion on temperatures in the crust and the way this can complicate interpretation of cooling ages has been a venerable subject explored many times in both one and two dimensions. Unlike other thermochronological systems, the ~70 $°$C closure isotherm pertinent to the U-Th/He system will be quite sensitive to topography at scale lengths that would seem to require a 3D approach to sampling, data interpretation, and modeling. As we illustrate with models and data from two end members, these complications in the temperature field are relevant to both older, more slowly eroding settings as well as active, rapidly exhuming settings where extreme erosion rates are in play. Solution of the transient heat flow equation in three dimensions identifies the thermal and temporal structures predicted for these two end-members. In older, more slowly eroding regions, such as the Appalachian Blue Ridge, relief is lower but the longer time scales and larger topographic wavelength conspire to allow non-trivial deflection of

shallow isotherms that can thwart simple sampling strategies based on 2D age-elevation transects. In mountains such as Nanga Parbat and Namche Barwa in the Himalaya and the Southern Alps in New Zealand, rapid exhumation leaves shallow isotherms pushed well up into topography and sub-parallel to the topographic surface. Although the situation is complex, 3D modeling can help identify experimental and sampling strategies that permit interesting questions to be addressed in mountain-scale landscape evolution, such as the degree of lateral migration of mountainous topography. One simple approach is to generate predictive age-residual maps where the modeled 70 $°$C closure surface is subtracted from the DEM used in generating the 3D model. This reveals locations where sampling can yield ages with useful variation, as in the southern Appalachians where existing age-elevation transects have not been particularly revealing on their own in reconstructions of the post-orogenic evolution of that landscape.
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