EGU22-2277
https://doi.org/10.5194/egusphere-egu22-2277
EGU General Assembly 2022

PecubeGUI: a new graphical user interface for Pecube, introduction and sample-specific predictions of apatite (U-Th)/He and 4He/3He data in the Rhone valley, Switzerland.

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Quantifying the rate and timing of landscape evolution is required to better understand the interaction between tectonic and surface processes and the potential influence of climate change on million-year time scales. Pecube is a 3D thermo-kinematic model capable of predicting low-temperature thermochronometric ages based on variable rock exhumation within an evolving topography driven by tectonic and surface processes. Pecube has been widely used over the past two decades to constrain the timing and rate of relief development, model paleo topographies, establish robust sampling strategies, and track the evolution of glaciated landscapes. Since its initial development by Braun (2003), many new functionalities have been added to Pecube to incorporate lower-temperature thermochronometers (e.g., OSL), lateral advection along faults, and the ability to provide topography evolution scenarios resulting from a surface processes model (SPM). Although widely used, the current version of Pecube (1) still necessitates the use of a non-user-friendly terminal, and (2) lacks sample-specific thermochronometric predictions, including radiation-damage dependent helium diffusion models for (U-Th)/He-based thermochronometers. These two shortcomings may limit the use of Pecube by the community.

Here, we introduce a newly developed graphical user-friendly interface for Pecube, called PecubeGUI, which incorporates new tools intended to clearly guide the user through all model input parameters for all functionalities of Pecube. Among them, the user is now able to simply load topographic files from a digital elevation model (DEM) or a SPM, and interactively set (i) the topographic evolution scenario by direct visual inspection, and (ii) the corresponding steady-state geotherm. PecubeGUI also enables the ability to predict ages in specific locations on a DEM with the use of up-to-date models for helium production and diffusion in apatite. For a single synthetic grain, the user can choose between several diffusion models, and can define zonation. In addition, ^{4}He/^{3}He release spectra can be predicted and compared with observed data.

To illustrate the capabilities of PecubeGUI, we present a case-study that couples a glacial landscape evolution model (iSOSIA, Egholm, 2011) with updated Pecube functionalities. We use a forward modelling approach to assess the capability and sensitivity of apatite (U-Th)/He and ^{4}He/^{3}He thermochronometric data, to constrain the spatial and temporal distribution of glacial erosion at exceptionally high-resolutions in the Rhone valley (Swiss Alps) over multiple Quaternary glaciations. There, apatites show a potential for variable damage accumulation (eU = 12-280 ppm),

implying variable single-grain closure temperatures. Previous modelling works suggest glacial incision at 1 Ma (Valla et al., 2011; Valla et al., 2012). With the observed data as constraints, we discuss how single-grain age predictions with detailed production-diffusion models (including the effect of radiation damage), can be used to (1) strategically establish the most effective sampling sites; and (2) constrain the spatial and temporal distribution of glacial erosion at the scale of a landscape, as well as at individual sampling sites.