EGU22-7288
https://doi.org/10.5194/egusphere-egu22-7288
EGU General Assembly 2022

Assessing burial history using stylolite roughness paleopiezometry with a twist in the Umbria-Marche Apennine Ridge

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Stylolite are rough structures developed by pressure solution, usually related either to burial stress or to tectonic contraction. The stylolite roughness, i.e., the difference in height between two points separated by a given distance along a track, yields quantitative information about the normal stress applied to the stylolite plane. The stress magnitude is accessed by applying signal analysis such as Average Wavelet Coefficient (AWC) or Fourier Transform (FT) onto a stylolite track, returning a characteristic length (cross-over length, L_c) at which two regimes of self-affine properties switch. In the case of a sedimentary, bedding-parallel stylolite, L_c scales to the magnitude of the vertical principal stress σ_1, hence to the burial depth at the end of the life of the studied stylolite. When applied to bedding-parallel stylolite populations in foreland basins and fold-and-thrust belts, this Stylolite Roughness Inversion Technique / paleopiezometer (SRIT) allowed estimating the maximum burial experienced by a strata before σ_1 became horizontal at the onset of tectonic contraction. We have collected hundreds of stylolites in the Meso-Cenozoic carbonate sequence along a wide SW-NE transect across the Umbria Marche Apennine Ridge (Apennines, Italy). On this dataset we conducted stylolite roughness inversion with both FT and AWC in order to quantify the maximum burial reached in the different parts across the belt before the Apenninic contraction begun. Doing so, we observed some discrepancies between L_c values obtained by either one or the other signal analysis method, implying a user dependent choice of the method based on best fit of the treatment and on consistency between all results. In order to (1) find the source of this difference, (2) correct this effect and (3) assess whether it impacts the derived vertical stress magnitude, we built virtual composite stylolites by assembling consistent stylolite tracks together to increase the range of roughness covered by the signal analysis. We present a statistical comparison of the results of the application of SRIT on single tracks and on composite ones. In both cases, the resulting depths are of the same order of values, and within the range of uncertainties, allowing a confident reconstruction of the pre-contractional burial depth across the Umbria Marche Apennine Ridge. However, the resulting L_c are closer for the two regression methods in the case of composite stylolites. The new approach therefore reduces the risk associated with a choice between signal analysis methods related to the user and expands its easiness of application.

Key words: paleopiezometry, stylolites, compressive deformation, folding, vertical stress,

compaction and burial depth