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LINKING DIGITAL GEOMORPHIC PROPERTIES AND FISSION TRACK AGES

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Introduction

The last decade has witnessed major advancements in the understanding of surface processes. Beside the classic geomorphic methods, digital modelling techniques and thermochronological measurement technologies became available to analyse the dynamics of the surface evolution. Although theory predicts that denudational patterns are related to the thermochronological signal, this dependency has been established only on regional scales so far. Here we make an attempt to correlate fission track (FT) thermochronology with superficial patterns semi-quantitatively on local scale. The idea behind this analysis to pave the way to establish a relationship between the quantitative geomophometric parameters and the low-temperature thermochoronometric data.

Data and methods

For the analysis Corsica has been chosen. This is choice is advantageous because (1) the spatial distribution of FT samples reached now the appropriate density, and (2) the geological setting (including the uplift history) of the area is relatively simple and the glaciation has played only a minor role..

Concerning the topography, sophisticated derivatives of a mid-resolution (75 m) digital elevation model (DEM) have been calculated. As it was demonstrated earlier (Székely & al., 2002), the local slope histogram, a measure of surface ruggedness, shows similar spatial pattern as the FT ages or their exhumation thickness equivalents. Here two further derivatives, the mean and the standard deviation of the local slope distribution are correlated to the thermochronological data.

The slope histograms were calculated using a 10 km radius circular window, and the mean and the standard deviation were calculated for each point. The FT data were interpolated in two ways: a nearest neighbour interpolation were applied with maximum extent of 10 km to view the validity zone of each sample. Later a (linear) natural neighbour interpolation was applied to achieve a contionous data set.

Results and discussion

The resulting patterns (Fig. 1) are remarkably similar: as it can be expected from theory, the steeper average slopes are related to younger FT ages. Furthermore, increased standard deviation (a possible indication of bimodality or non-Gaussian behaviour) can also be correlated with young exhumation indicated by young FT ages.

The found correlation can be interpreted as two ways of manifestation of the differential uplift of the area. On one hand, the surface pattern is determined by the drainage pattern and the incision of its valleys. On long-term scale uplift leads to erosion, i.e., incision of the valleys. Incision increases the average slope angle and, under certain conditions, may lead to widening of the slope angle histogram, consequently to increased standard deviation of the slope distribution.

On the other hand, increased uplift (together with exhumation of the underlying rocks) will result in younger fission track ages, since the not yet cooled material approaching to the surface. These two effects having the same causal roots manifest in a correlative spatial pattern.

Outlook

According to our results the density and localisation of the FT sampling points (the “resolution” of the data, in other words) plays an important role. The presented patterns suggest that even in relatively tectonically undisturbed settings the FT age may have a higher spatial frequency than it was previously assumed. This interpretation imply denser sampling in the future. On the basis of the revealed correlation, further areas (e.g., the Alps) with appropriate data density will be included in this study. The other possibility for the in-depth study is if the analysis includes (U,Th)/He thermochronology, too.

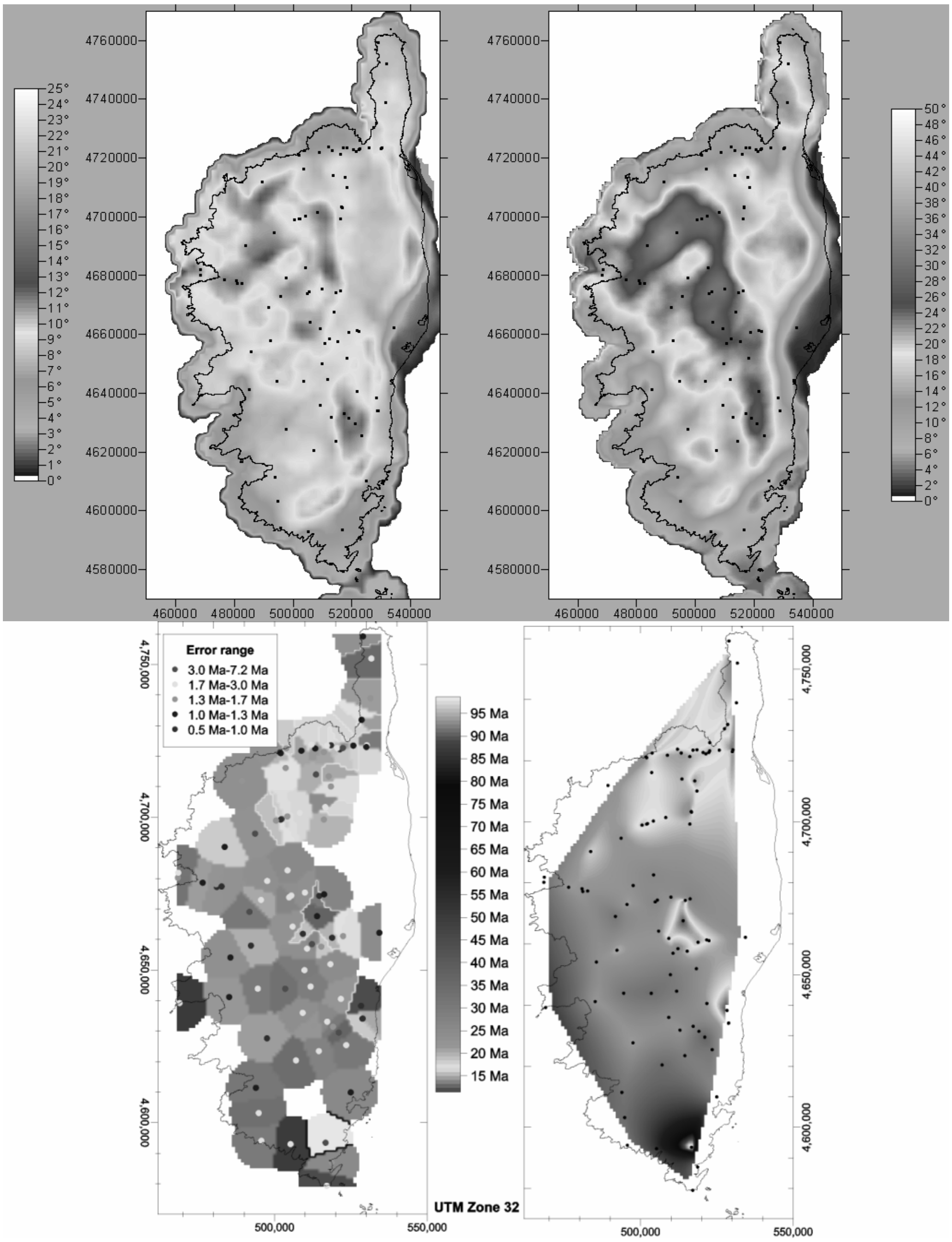

Fig. 1

Comparison of DEM derivatives (top panels) with fission track (FT) data pattern (bottom panels). Note the “cold spots” in the vicinity the Western coast. Top left panel: spatial distribution of standard deviation of local slope histograms calculated for 10 km radius circular windows. Top right panel: mean slope angle of local slope histograms (with the same window size). Bottom left panel: nearest neighbour interpolation of fission track (FT) age data compilation (Cavazza & al., 2001, Jakni & al., 2003 and our own data). Dots indicate the error of the individual data points. Bottom right panel: natural neighbour interpolation of the same FT data set .

References

CAVAZZA, W., ZATTIN, M., VENTURA, B. & ZUFFA, G.G. (2001): Apatite fission-track analysis of Neogene exhumation in northern Corsica (France). Terra Nova **13(**1): 51–57.

JAKNI, B.,VAN DER BEEK, P., POUPEAU, G., SOSSON, M., LABRIN, E., ROSSI, P. & FERRANDINI, J. (2003) Cenozoic denudation of Corsica in responce to Ligurian and Tyrrhenian extension: results from apatite fission-track thermochronology. Tectonics (in press, available on-line)

SZÉKELY, B., REINECKER, J., DUNKL, I., FRISCH, W. & KUHLEMANN, J. (2002): Neotectonic movements and their geomorphic response as reflected in surface parameters and stress patterns in the Eastern Alps. EGU Stephan Mueller Special Publication Series , **3** , 149-166.