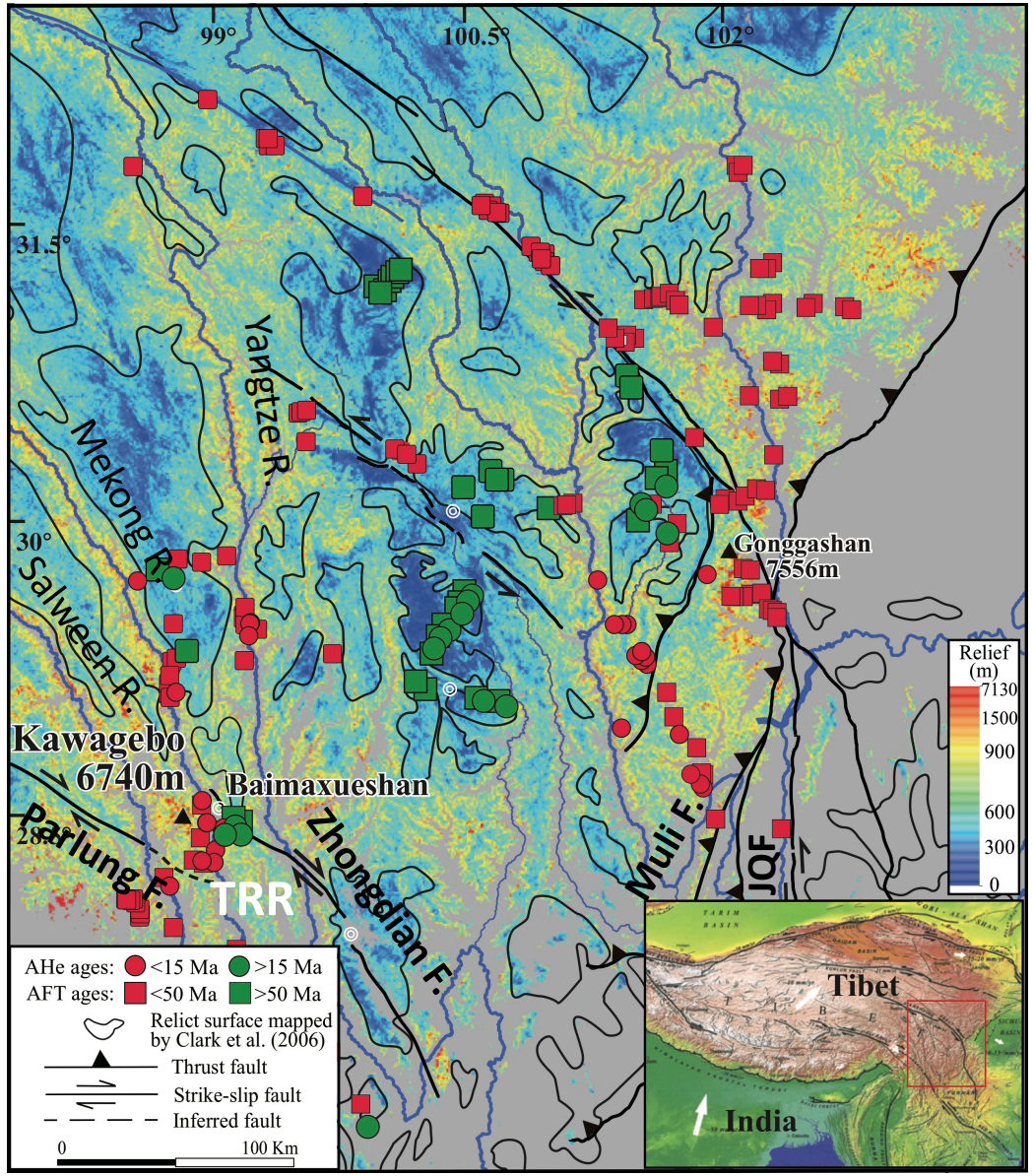


Contrasting exhumation histories and relief development within the Three Rivers Region (Southeast Tibet)

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1 Institut des Sciences de la Terre (ISTerre), Université Grenoble Alpes, CNRS, IRD, Grenoble, France
2 Institute of Geosciences, Potsdam University, Potsdam, Germany



Zhang et al., 2015

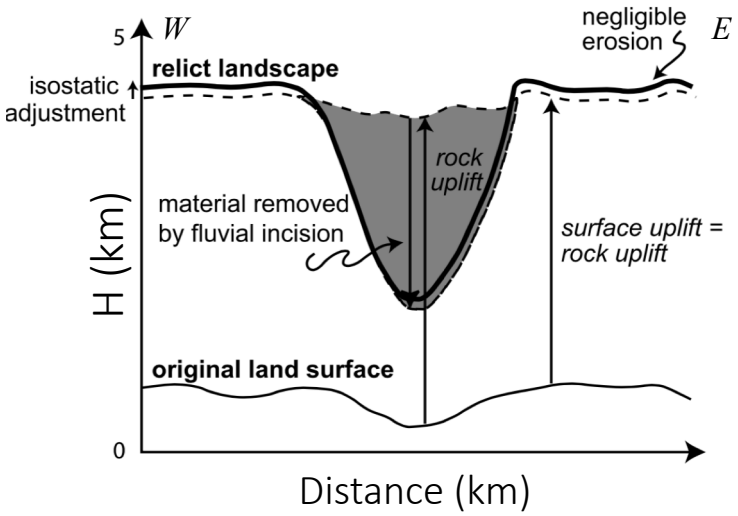
TRR: Three Rivers Region

Topography in SE Tibet:

- Gentle south-eastward gradient of topographic decrease in TRR
- Topographic step along Muli-Jinhe-Qinhe thrust belts
- Negative topography: low-relief at high-elevation & high-relief at low-elevation
- Perched relict surfaces (relief<600 m) dissected by large rivers: old thermochronological ages and little exhumation

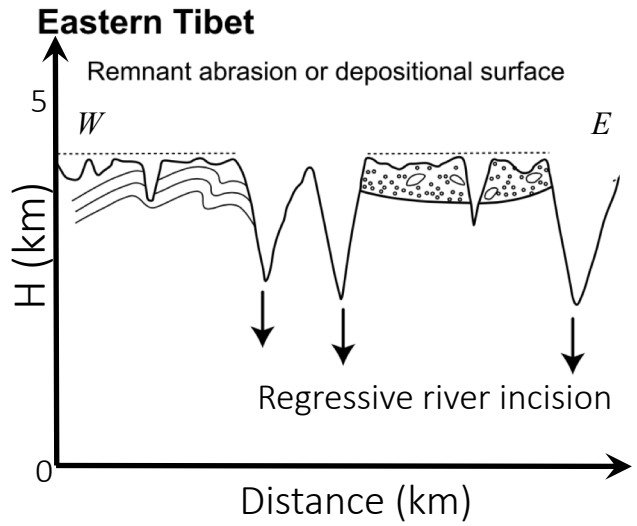
Topographic models:

- Relict surfaces: Regional uplift by lower crust channel flow and coevally regressive erosion *(Clark et al., 2000).*



Clark et al., 2000

- Surface uplift by thrusting, dissected by regressive erosion *(Liu-Zeng et al., 2008).*



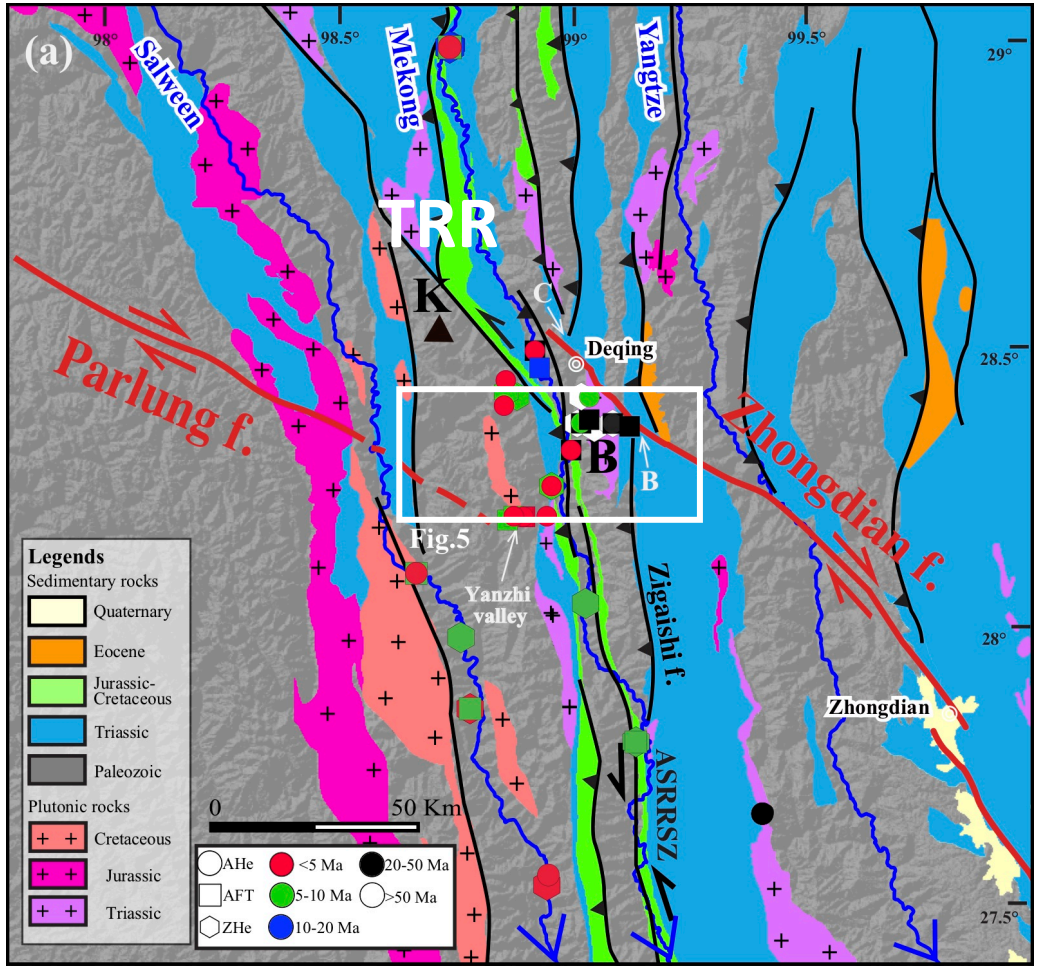
Liu-Zeng et al., 2008

Questions:

1. Could all low-relief surfaces be classified as relict surfaces?
2. Other potential mechanism of the low-relief generation?
3. Exhumation of low relief surfaces during India-Asia collision?

Study zone: *Three Rivers Region*

- Low-relief Baimaxueshan/High relief Kawagebo massifs
- Transition zone of high strained Eastern Himalayan Syntaxe and less deformed SE Tibet

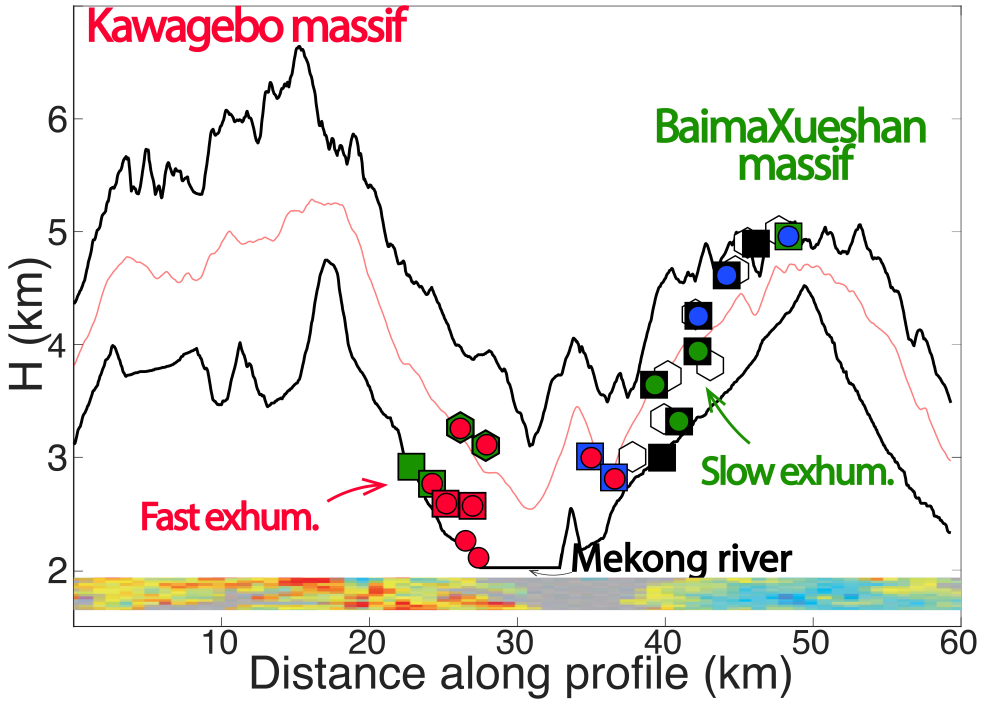


Ou et al., 2021

TRR: Three Rivers Region

Kawagebo & Baimaxueshan Massifs

- Thermochronology ages contrast
- Geomorphology contrast

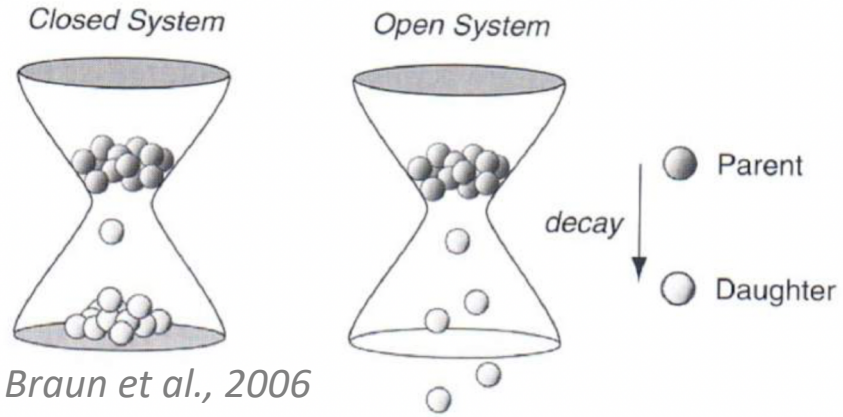


Ou et al., 2021

Methods: low-temperature thermochronology

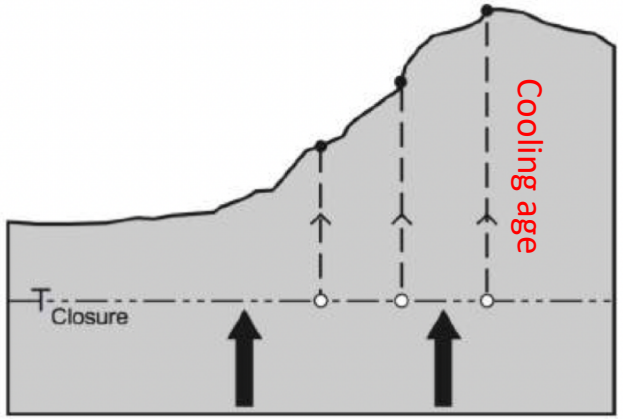
- Based on radioactive decay of parent elements (in apatite & zircon): ((U-Th)/He and Fission trace; AHe, ZHe, AFT et ZFT
- *Closing temperature*: temperature at which the radioactive system closes
- *Cooling age*: exhumation time from closing T to surface
- *Exhumation rate:* slope of elevation-age plot

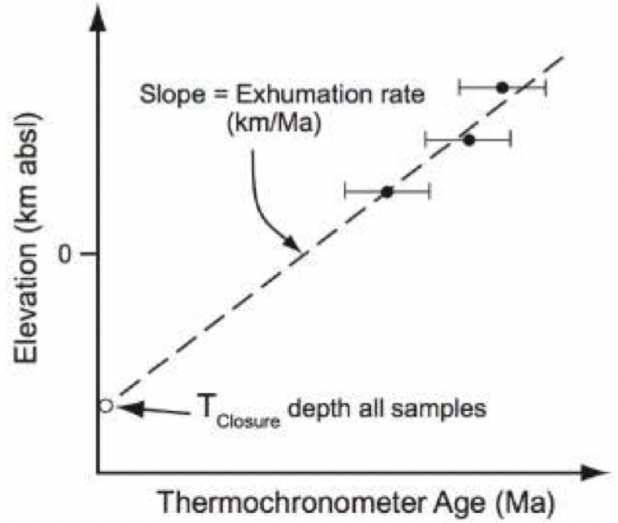
Radioactive system:



Braun et al., 2006

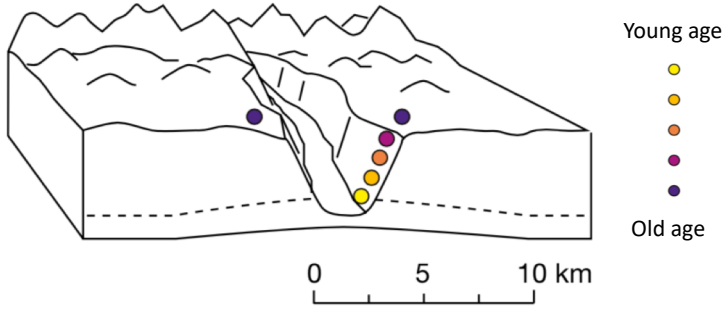
A. Vertical exhumation



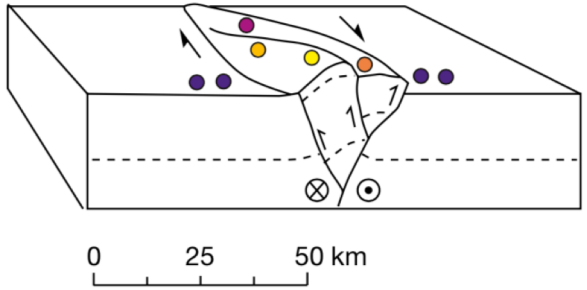


Ehlers et al., 2005

B. Valley incision



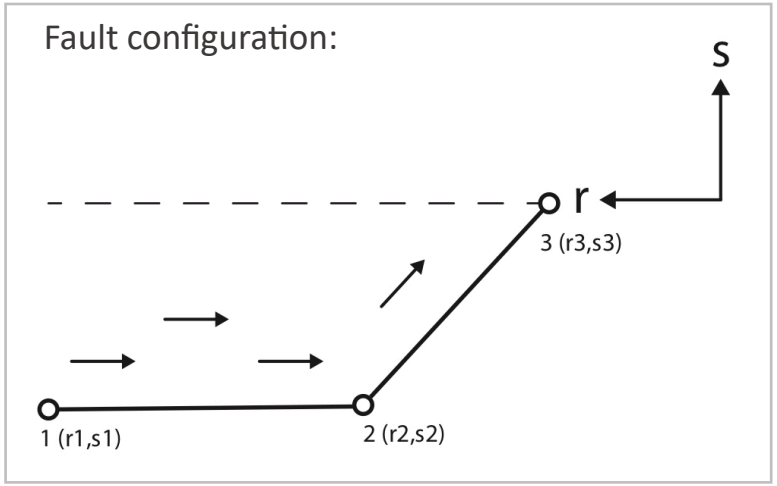
C. Transpressional strike-slip



Schildgen et al.,2018

Methods: inverse thermo-kinematic modelling (Pecube) to solve the heat production/diffusion/advection equation.

Thermochronological data ⟷ Thermal history of the crust

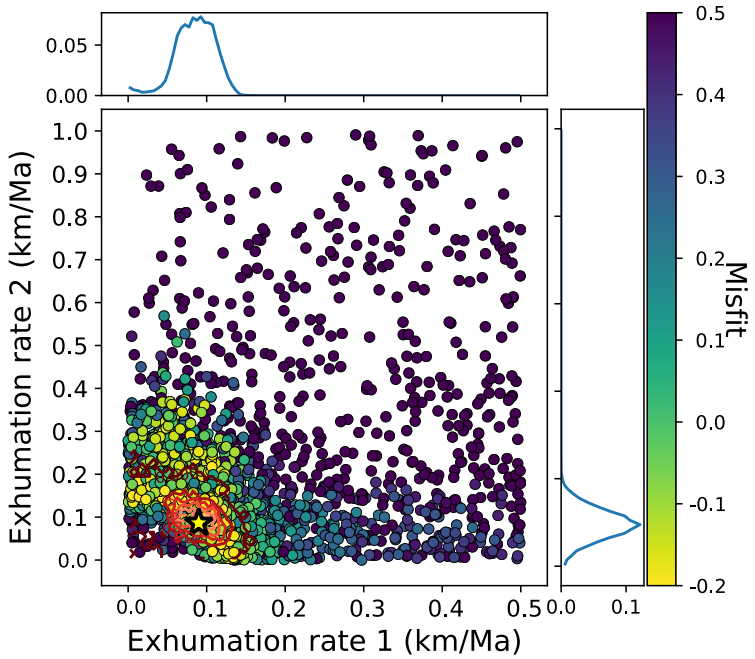


Steps:

1. Set parameters: topography/exhumation rate/crust thermal structure/fault configuration...
2. *Forward modeling*: crustal thermal history → predicts cooling ages
3. *Inversion method*: thermochronological ages → predicts crustal thermal history
4. Optimize parameters (illustrated in PDFs) with a min misfit by comparing of predicted/observed ages:

$$ø = \sqrt{\sum_{i=1}^{N} \frac{(\alpha_{i,obs} - \alpha_{i,pre})^2}{\sigma_i^2} / N}$$

PDFs':



Objectives:

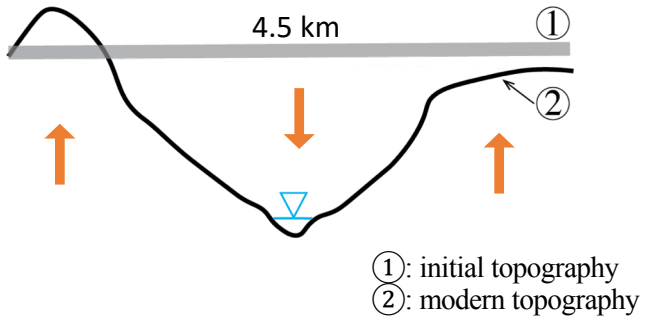
- Define the kinematics and timing of exhumation
- Model the first-order fault geometry for Kawagebo massif

Dataset:

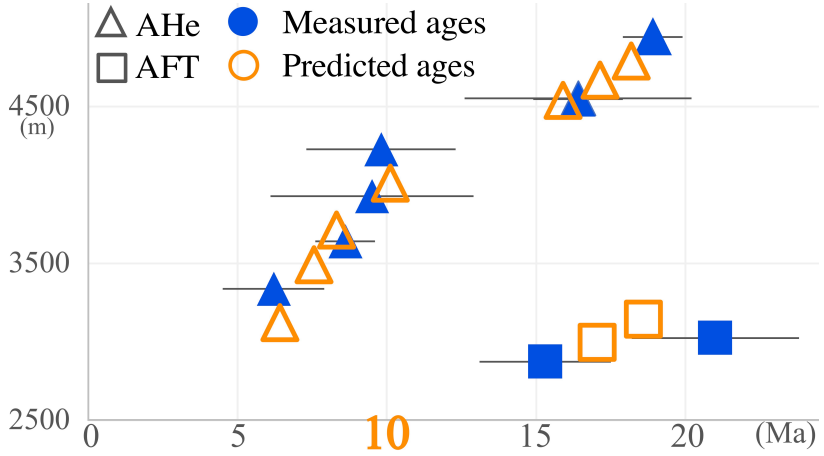
- 11 samples for Baimaxueshan massif, 8 samples for Kawagebo massif
- 3 different thermochronolometers: AHe, AFT, ZHe

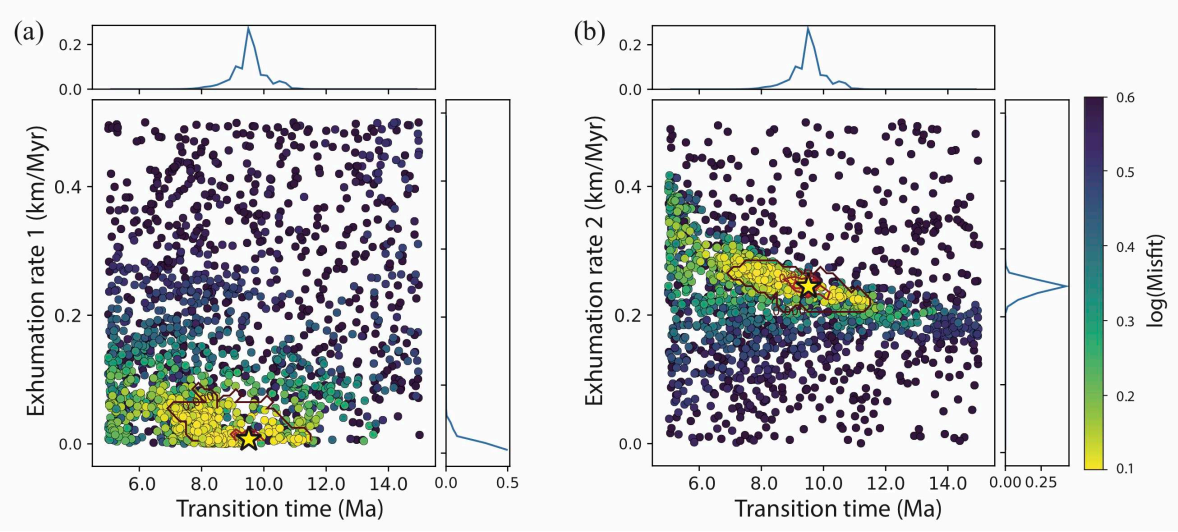
Pecube modelling: BaimaXueshan massif

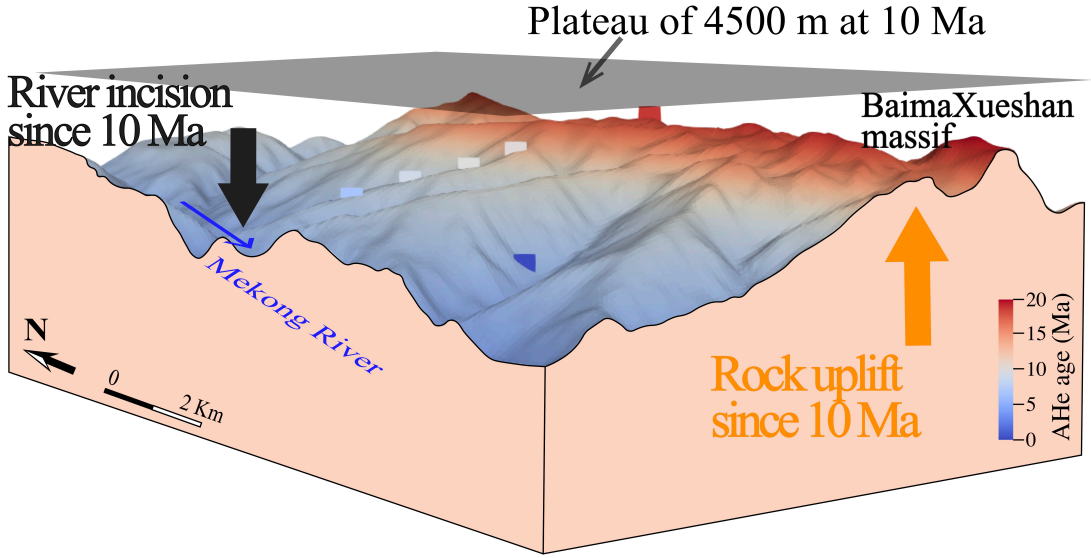
Plateau scenario: AHe, AFT



Best model:
Exhumation: 22–10 Ma, 0.01 km/Myr
10–0 Ma, 0.25 km/Myr
Misfit: 1.16



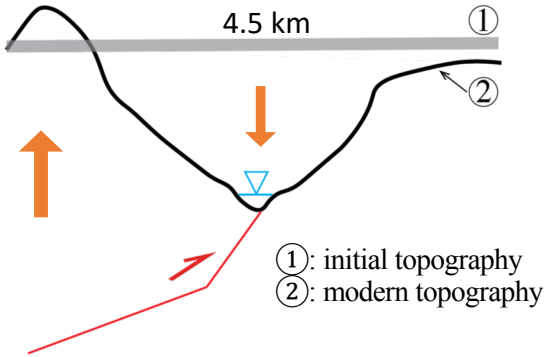




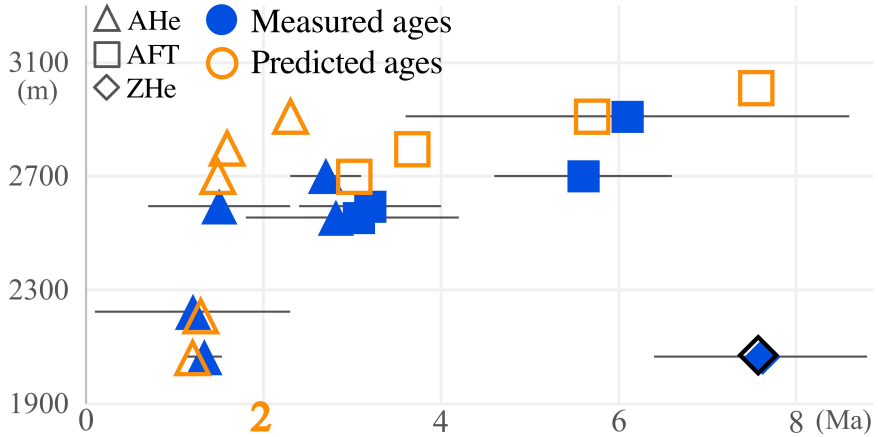
- Moderate rock uplift, combined with an additional Mekong river incision since 10 Ma → necessary to well reproduce ages and break-in-slope of elevation-age plot

Pecube modelling: Kawagebo massif

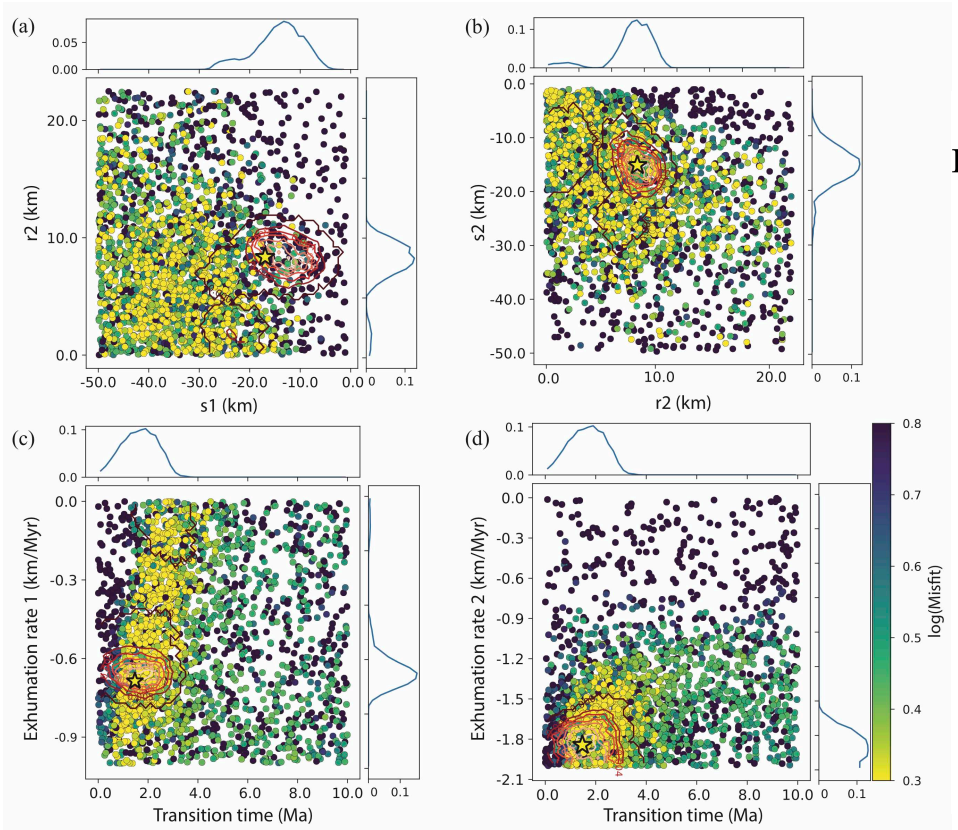
Tectonic+Plateau scenario: AHe, AFT, ZHe

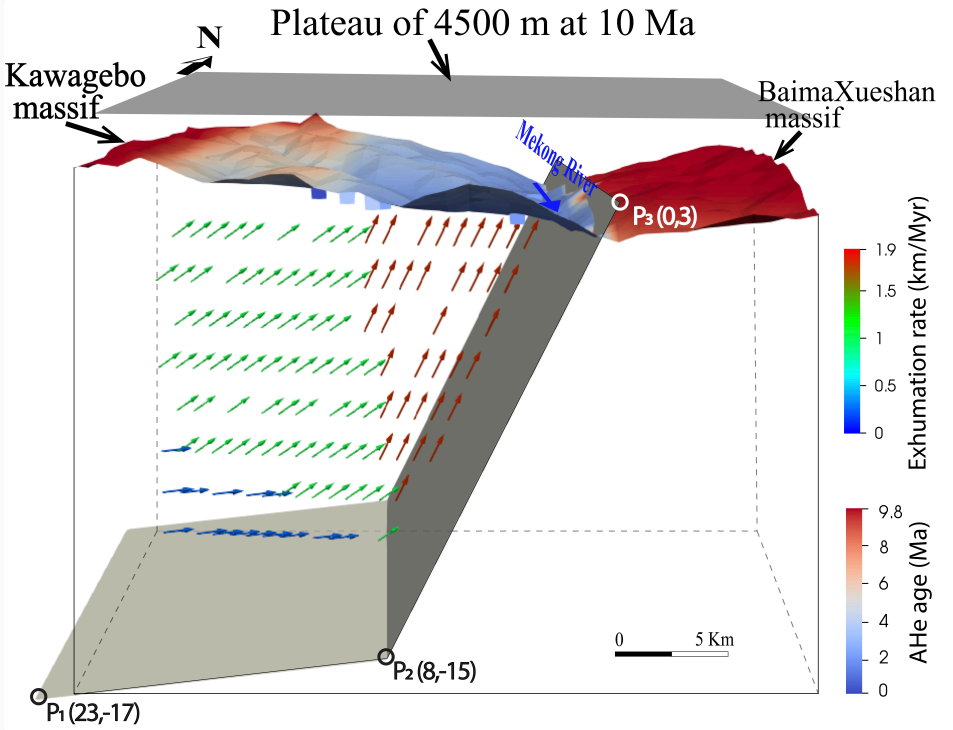


Best model:
Exhum.: 10–1.6 Ma, 0.45 km/Myr
1.6–0 Ma, 1.86 km/Myr
Misfit: 0.66



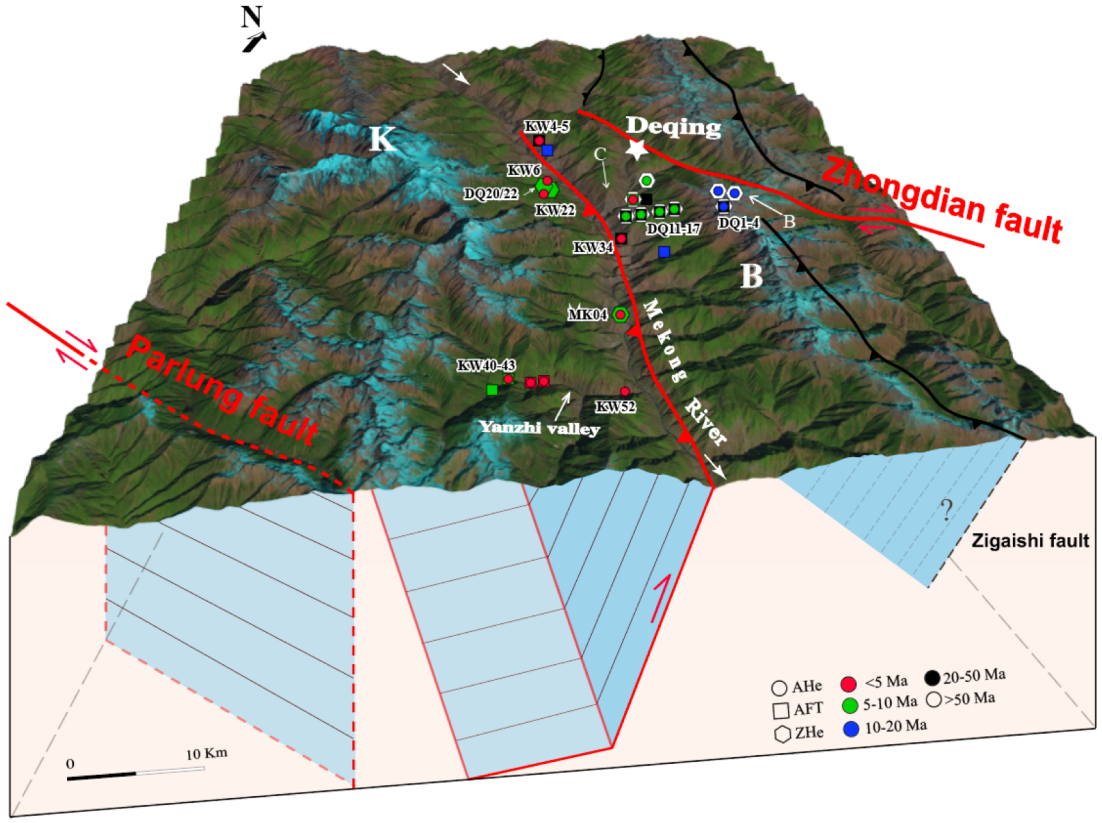
1. Rapid rock uplift, combined with an additional Mekong river incision since 10 Ma
2. Implementation of a steeply west-dipping thrust along Mekong river → necessary to reproduce age distribution in space
3. Reactivated thrust: transpression structure between Parlung/Zhongdian dextral strike-slip fault.

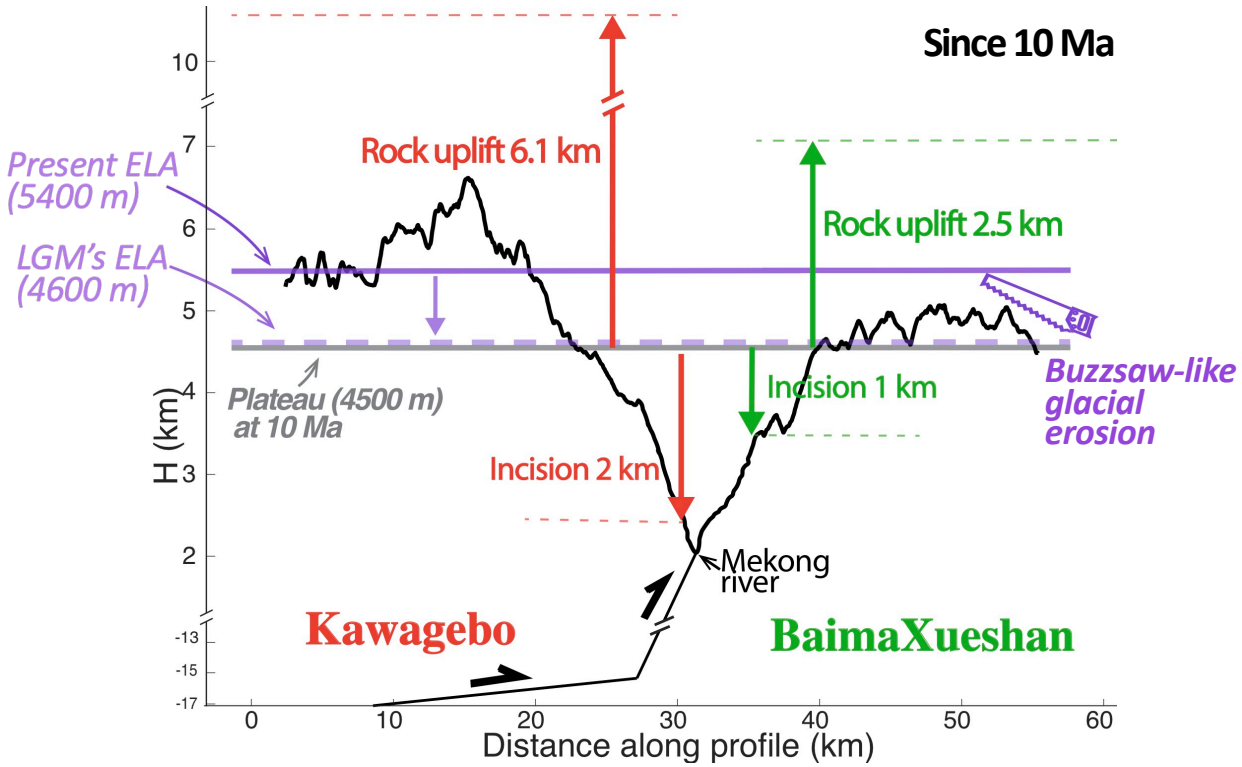




Conclusion:

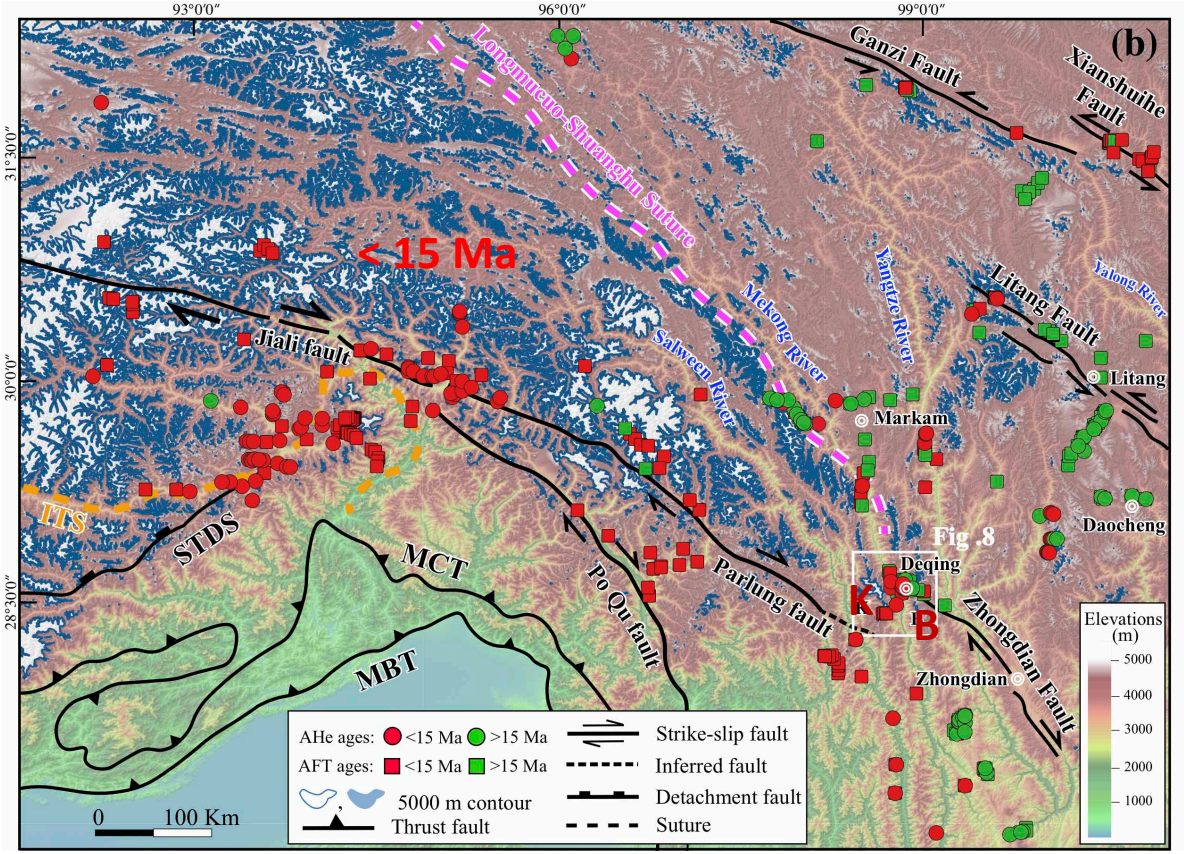
- Tectonic forcing is not expressed in exhumation before 10 Ma of BaimaXueshan massif
  No two-phases exhumation speculated by using pseudo-elevation profiles *(Liu-Zeng et al., 2018)*
- Removal of a overburden of 2.5 km since 10 Ma in BaimaXueshan: Monsoonal precipitation? Buzzsaw-like glaciation?
- Higher exhumation in Kawagebo dominated by a reactivated thrust in a restraining bend between Parlung and Zhongdian dextral strike-slip faults, since at least 10 Ma.
- Mekong river incision since 10 Ma, accounting for ~25-30% of total exhumation in both massifs.

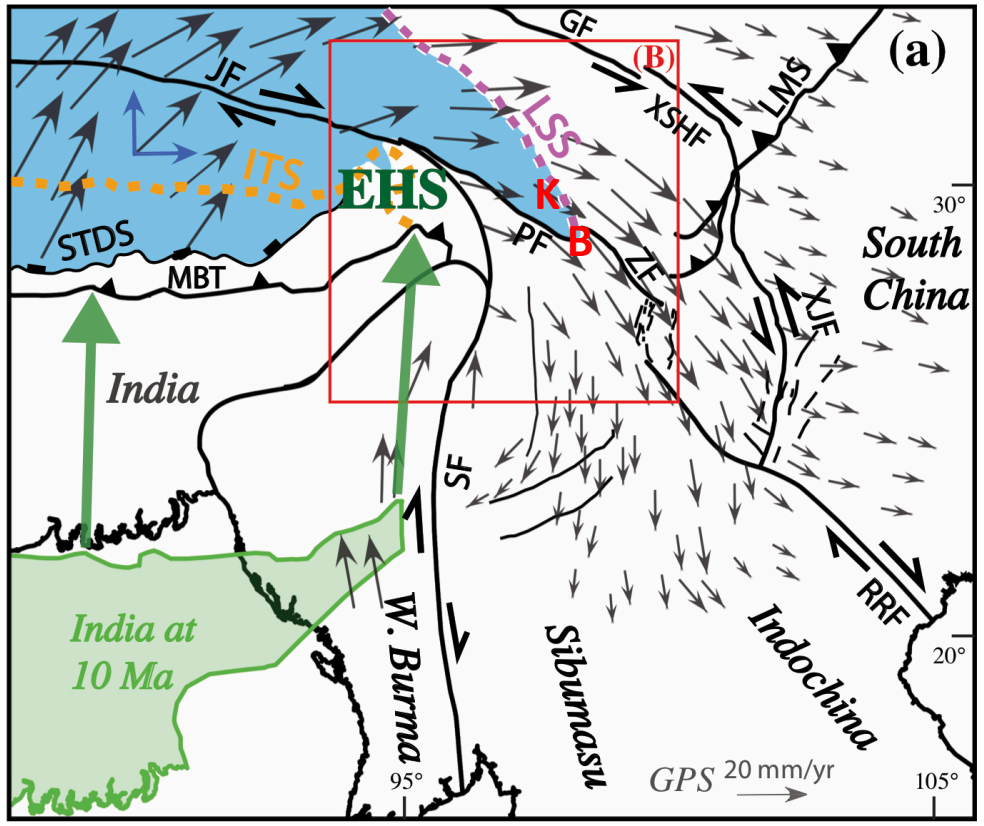




Conclusion:

- Regional uplift since ~10 Ma:
  - An excess of elevation at 5000 m (in blue) between India and Longmucuo-Shuanghu suture
  - In this region, young thermochronological ages (<15 Ma)
  - Related to the continuous northward convergence of India since 10 Ma





K: Kawagebo massif; B: BaimaXueshan massif; LSS: Longmucuo-Shuanghu Suture; PF: Parlung Fault; ZF: Zhongdian Fault; EHS: Eastern Himalayan Syntaxes