Tibetan Plateau palaeoglaciology – exposure ages, glacier altitudes, and palaeoclimate

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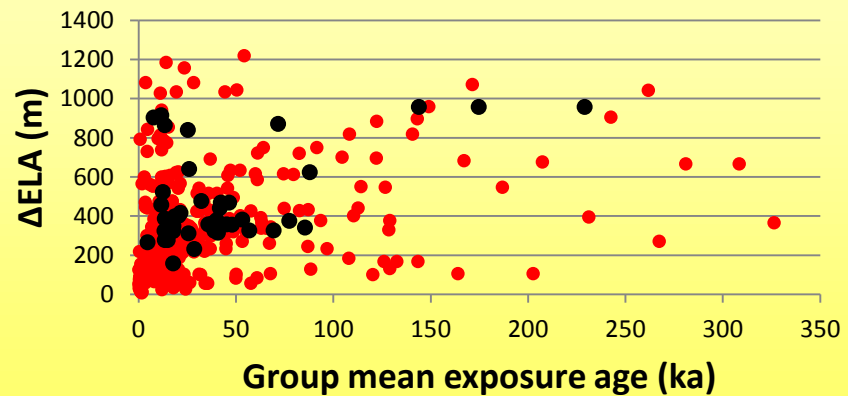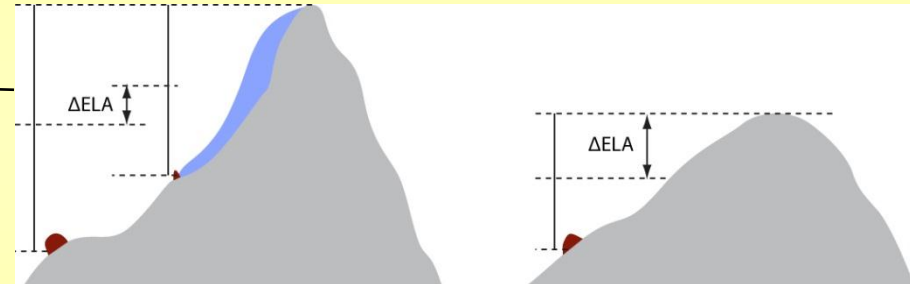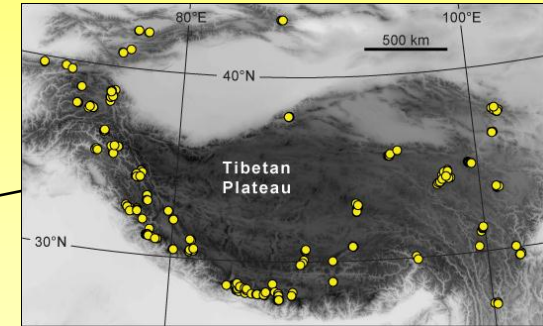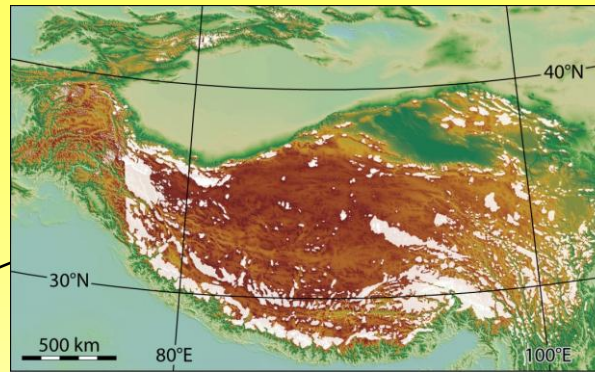
Outline

Introduction
  Background
  Aim

Methods
  Exposure ages
  ΔELA

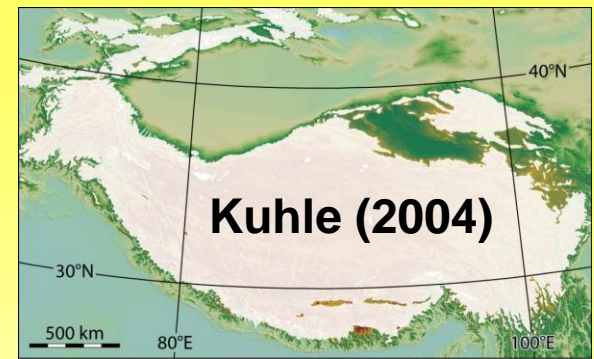**Data**

Conclusions

Limited alpine style glaciation of Tibet

Kuhle (2004)

500 km

Li et al. (1991)

40°N

30°N

500 km

80°E

100°E
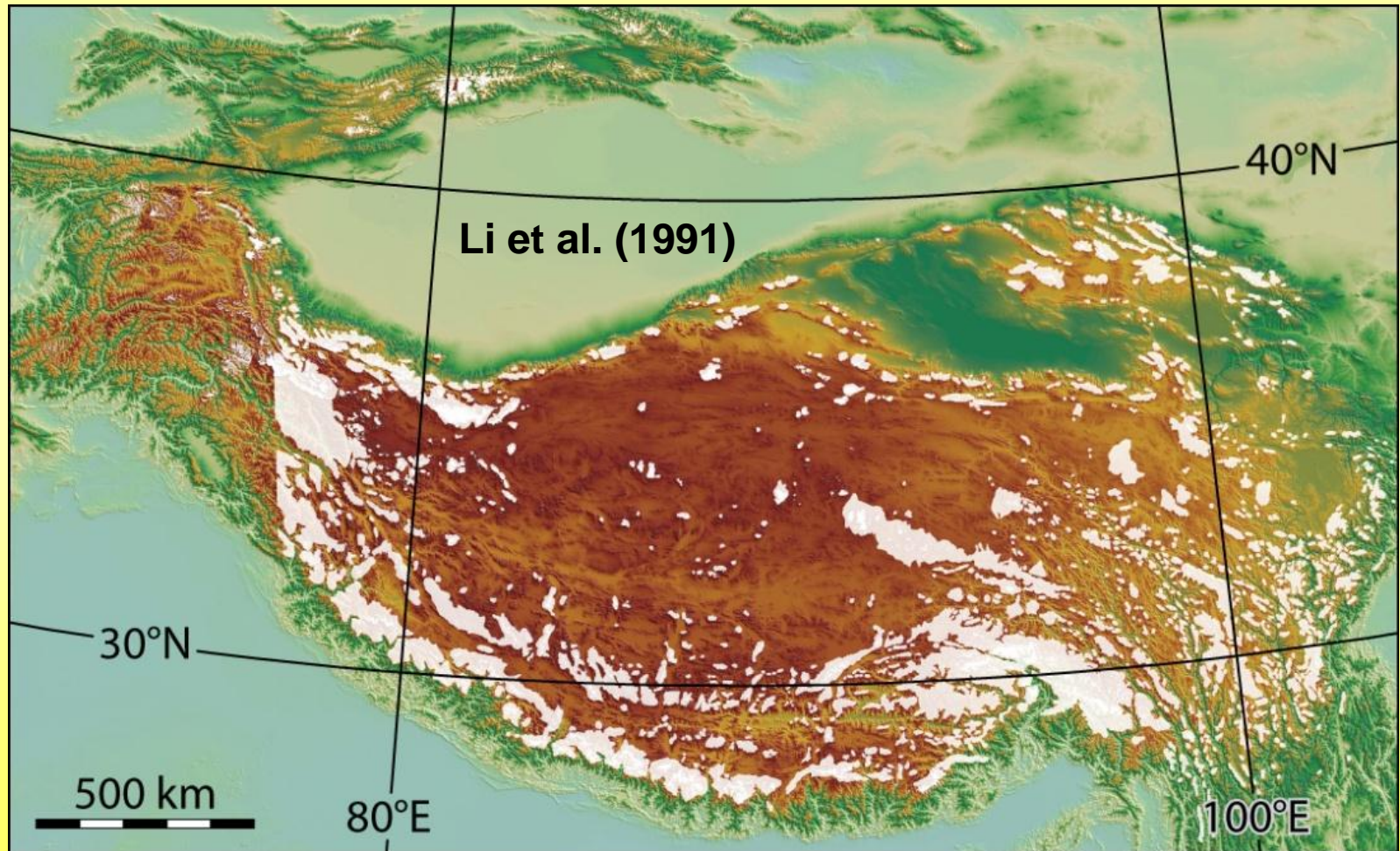
Extensive dataset of Tibetan Plateau exposure ages

Owen et al. (2008)

Heyman et al. (2011)
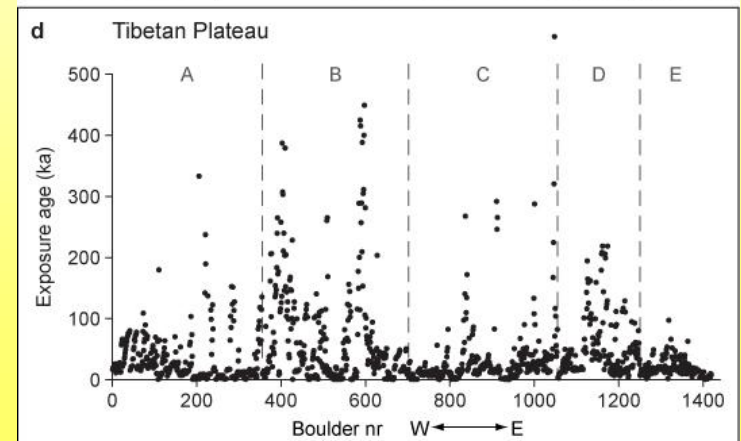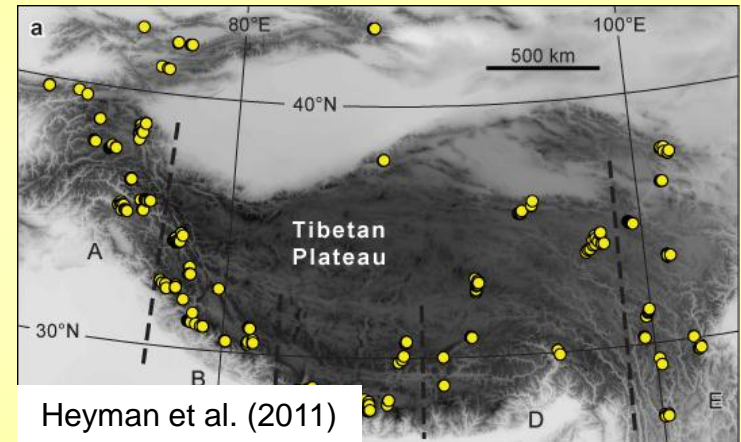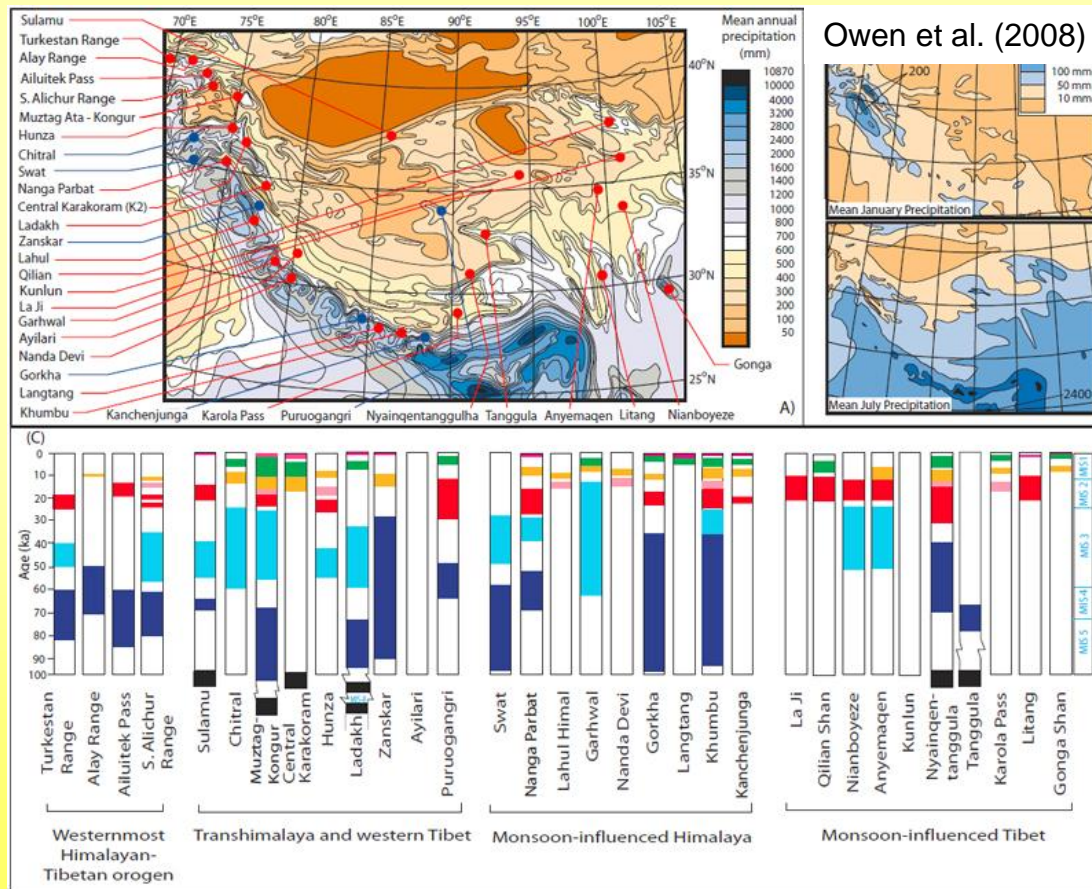
Few plateau-scale studies

Many local/regional studies

Owen et al. (2008)
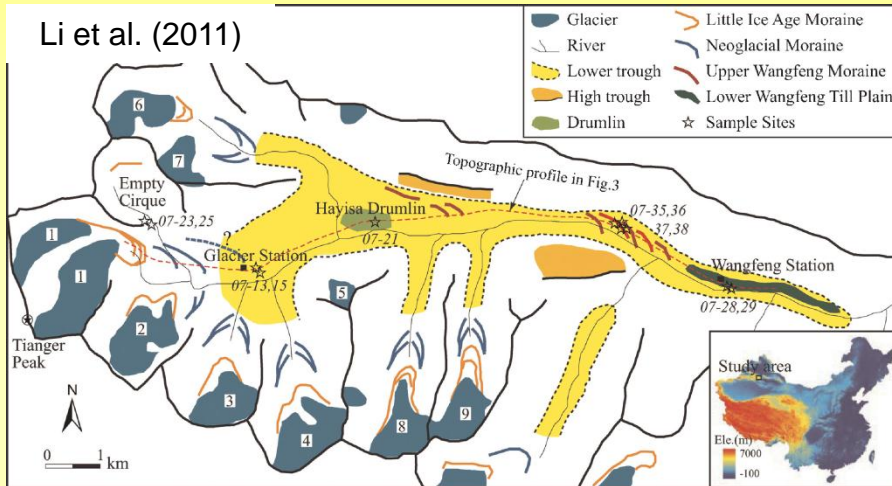
Li et al. (2011)

Owen et al. (2011)
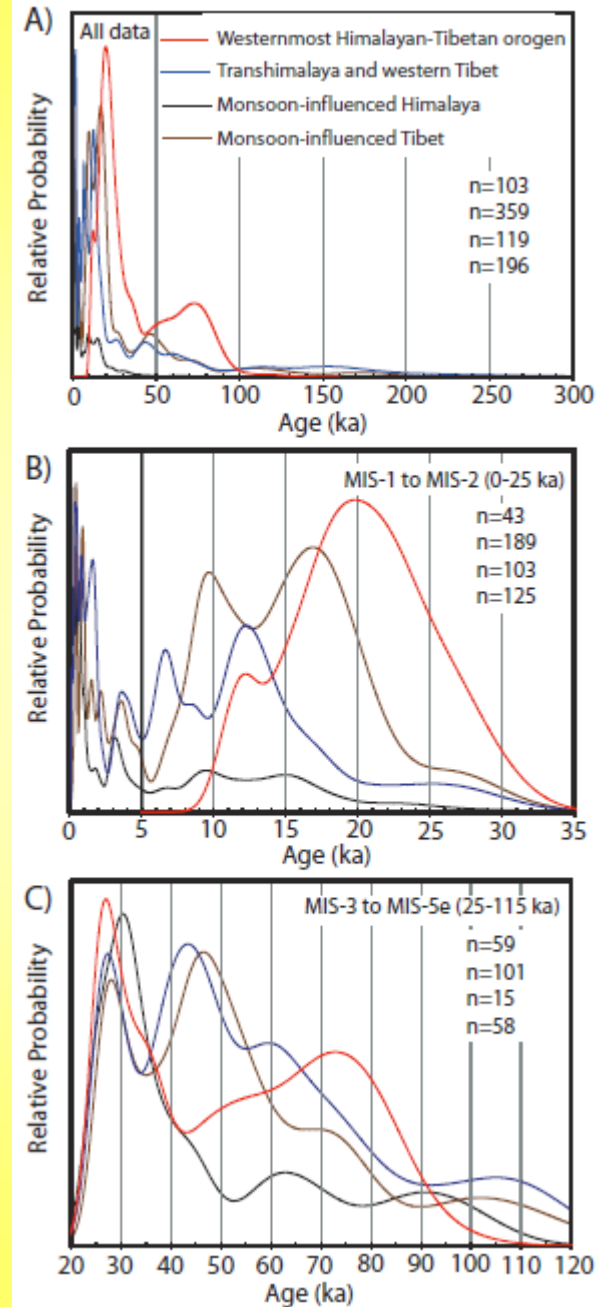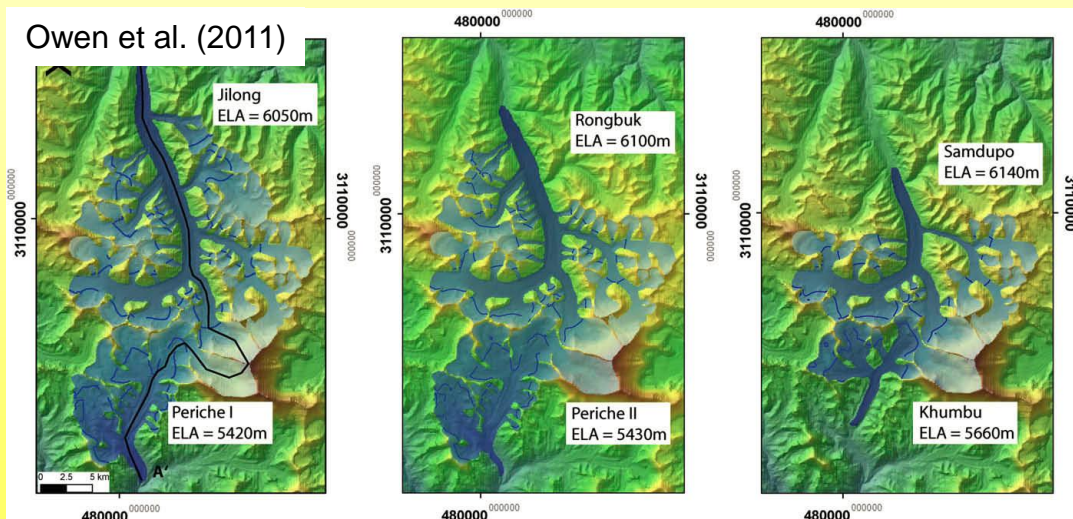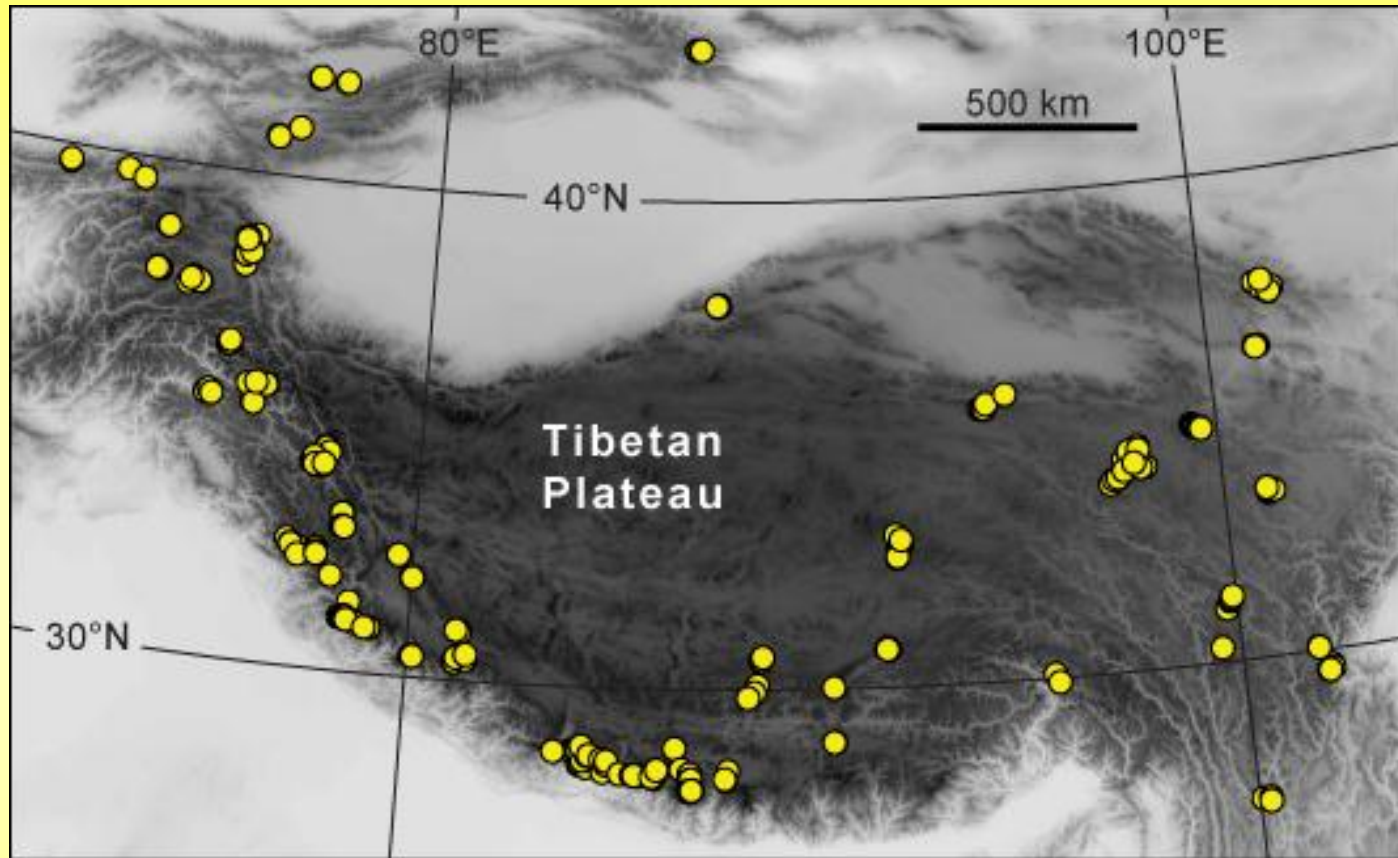
Aim:

Present a plateau-scale dataset of ^{10}Be exposure ages and ΔELA estimates to enable large-scale evalutation of temporal and spatial glacier evolution patterns
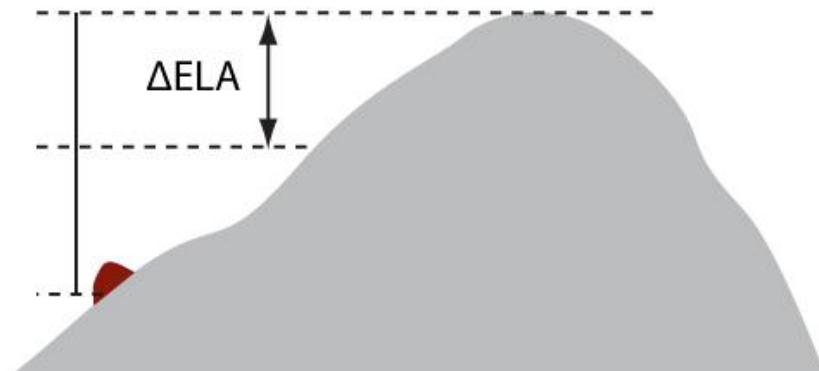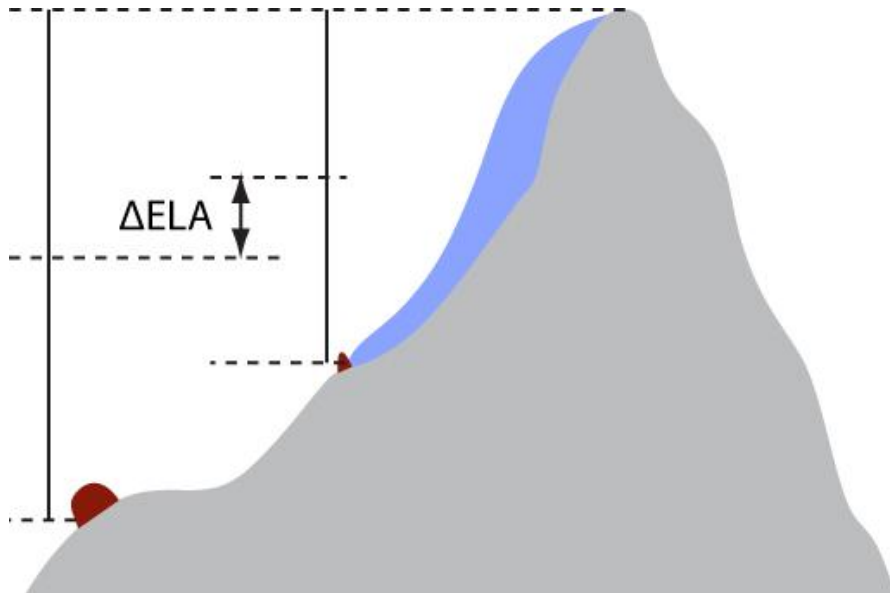
Method: Exposure age compilation

Included: All ^{10}Be exposure ages of boulders and pebbles deposited by former glaciers on the Tibetan Plateau (modified from Heyman et al. 2011: EPSL): **1544 samples, 355 sample groups**

All exposure ages recalculated using the CRONUS online calculator (Balco et al. 2008: QG)
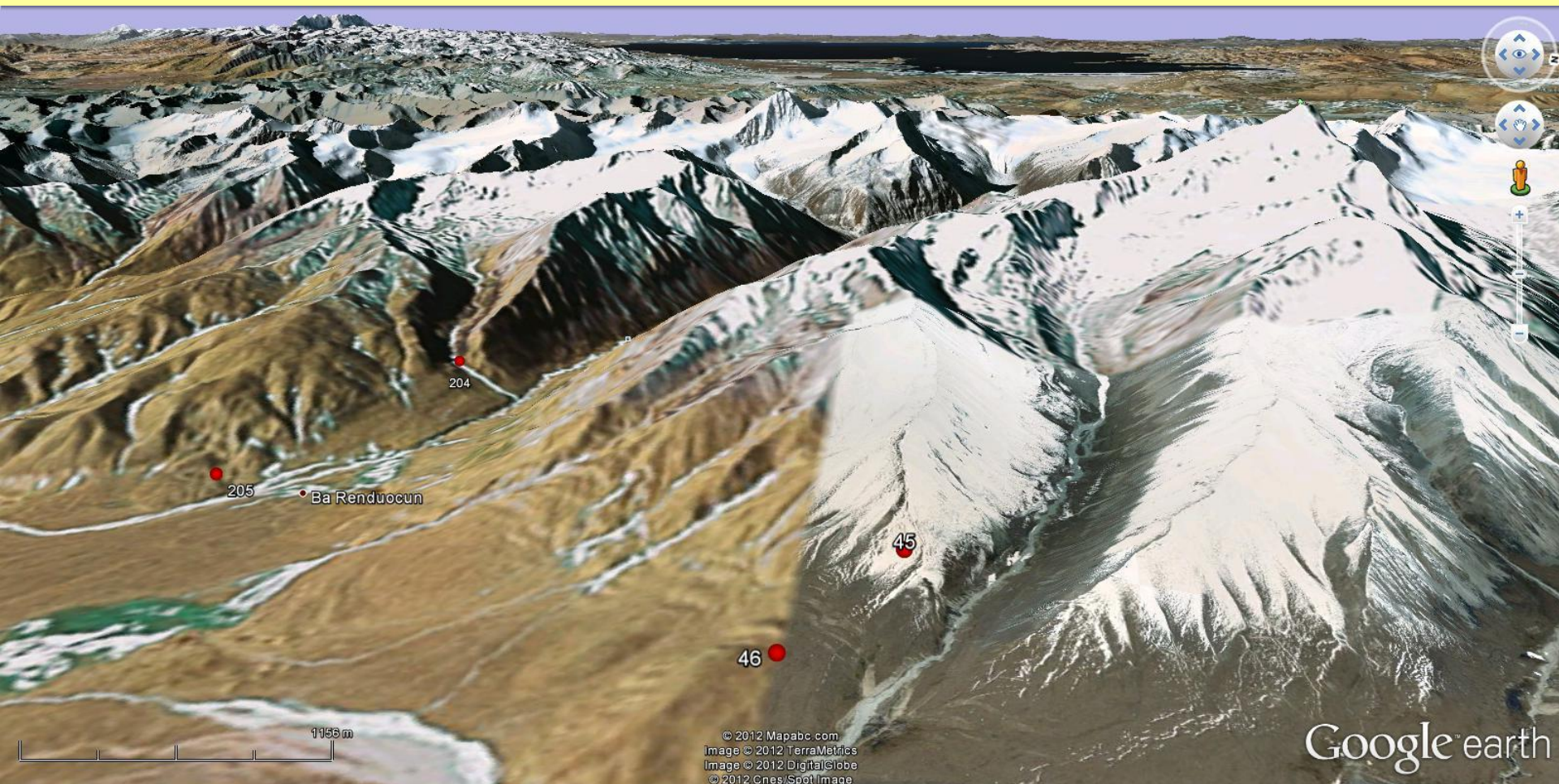
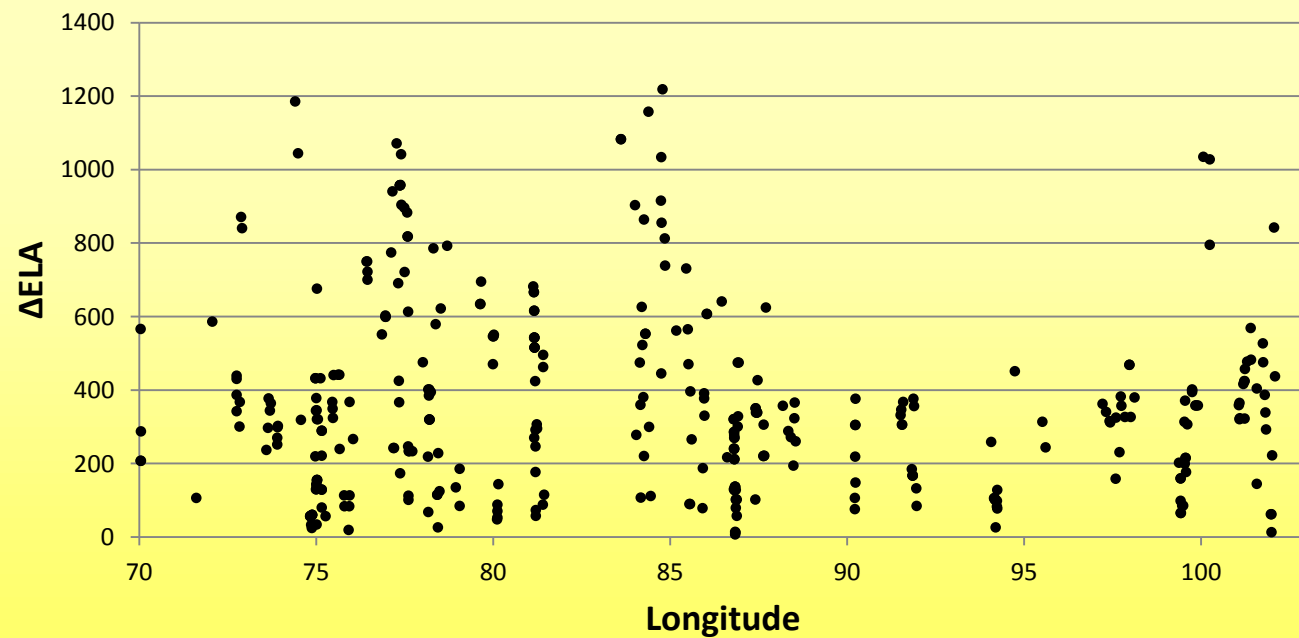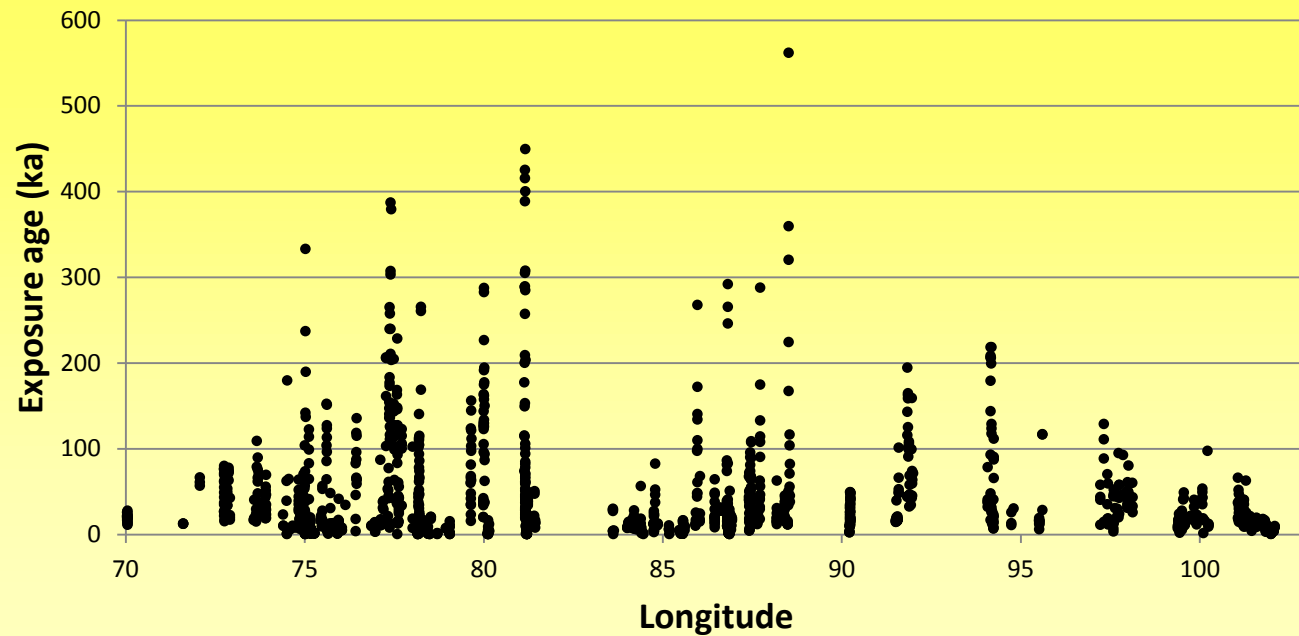# Method: ΔELA estimation

Toe to headwall altitude ratio

Method: ELA estimation

Altitudes and coordinates recorded using Google Earth

ΔELA and exposure age data
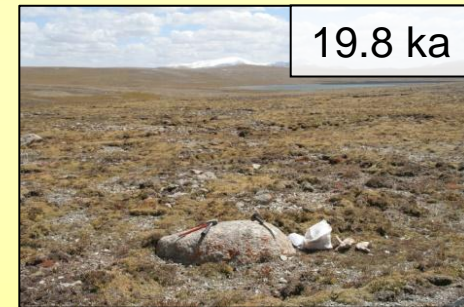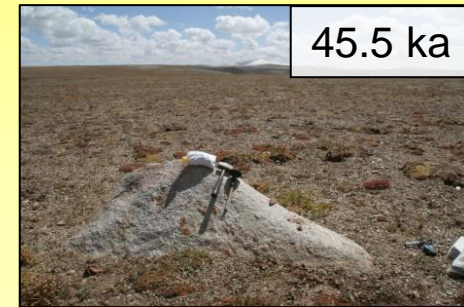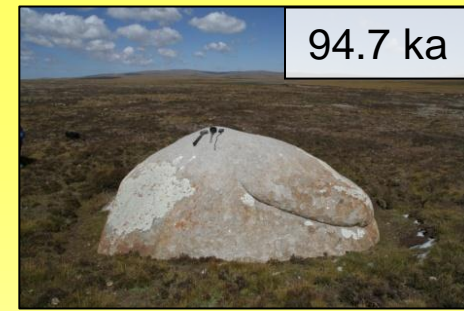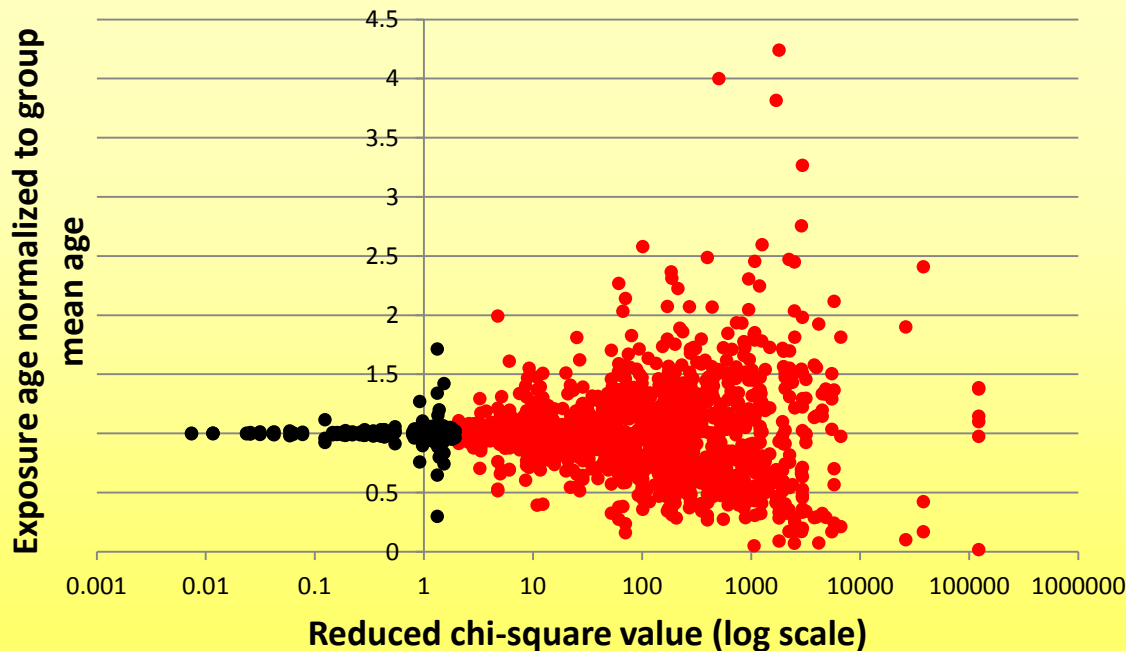
Problem: exposure age scatter

94.7 ka

Strategy: reduced chi-squared statistics

$$\chi_R^2 = \frac{1}{n-1}\sum_{i=1}^{n}\left[\frac{t_i - \bar{t}_i}{\sigma t_i}\right]^2$$

From Balco (2011: QSR)

45.5 ka

19.8 ka

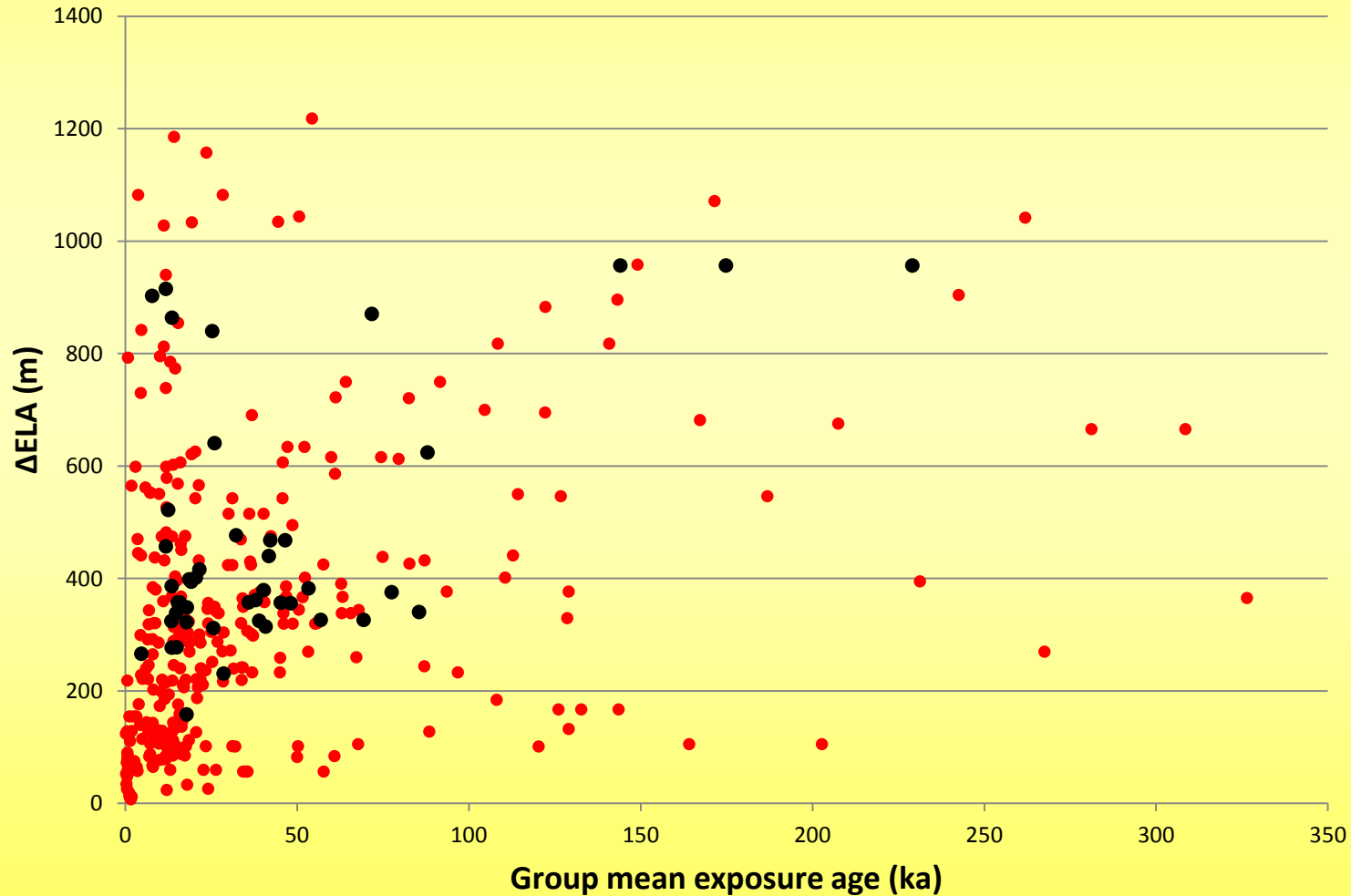Exposure age normalized to group mean age
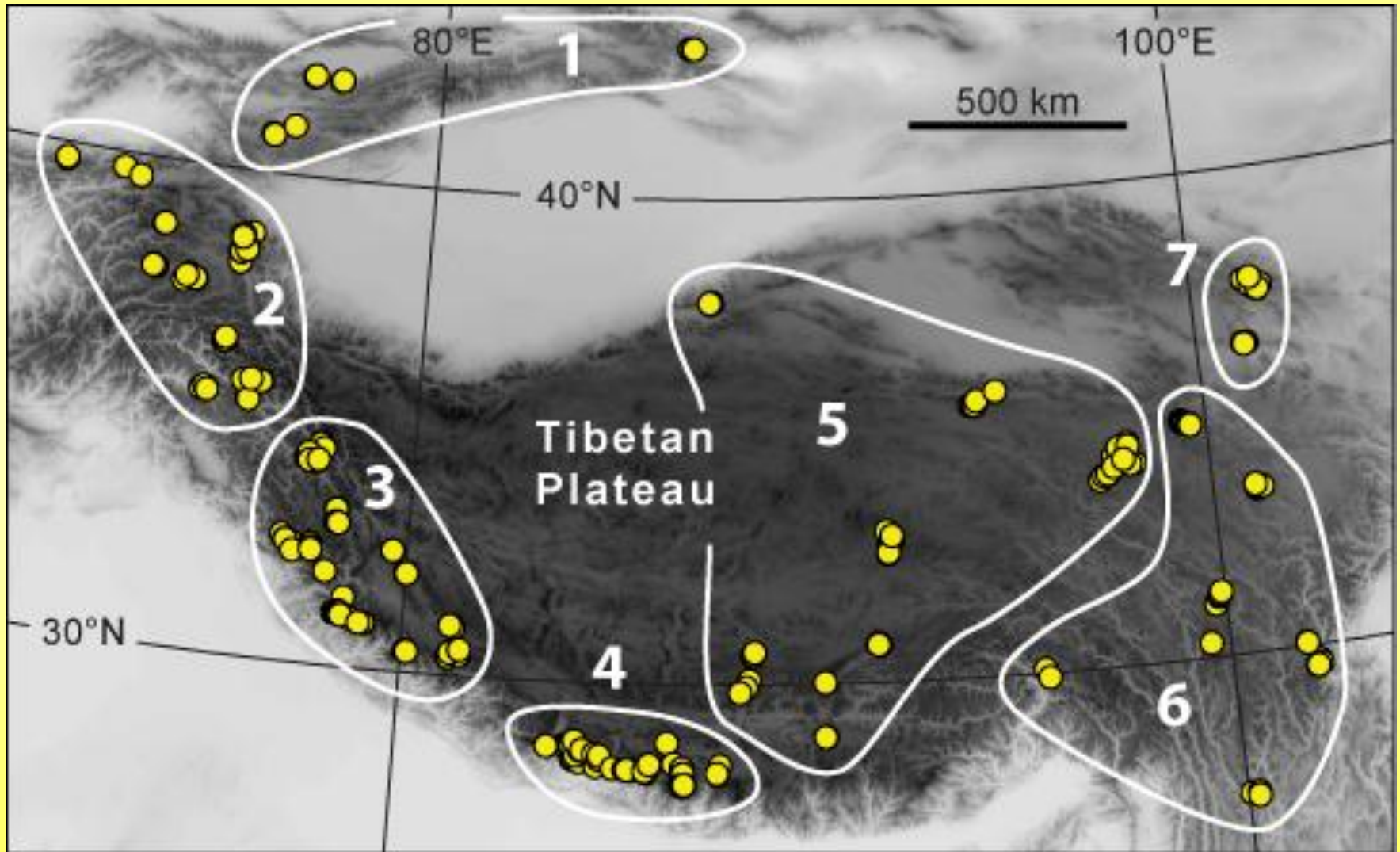
$X_R^2 < 2$ (53 groups)

$X_R^2 \geq 2$ (302 groups)

Reduced chi-square value (log scale)

ΔELA and mean exposure ages
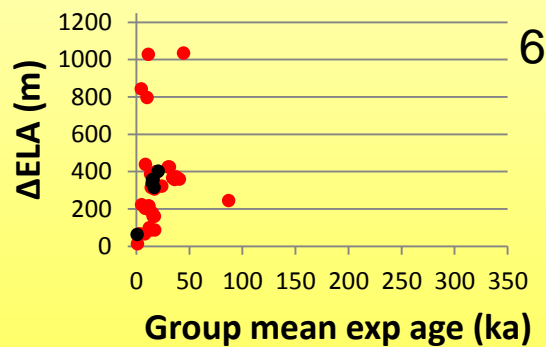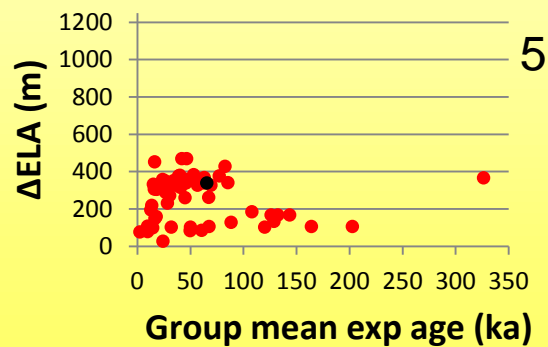
$X_R^2 < 2$ (53 groups)

$X_R^2 \geq 2$ (302 groups)

Seven regions
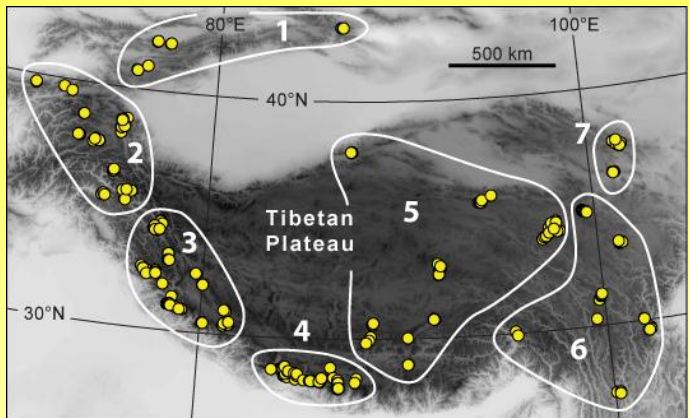
$X_R^2 < 2$
$X_R^2 \geq 2$
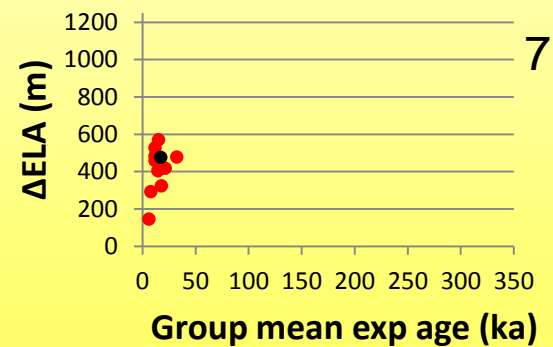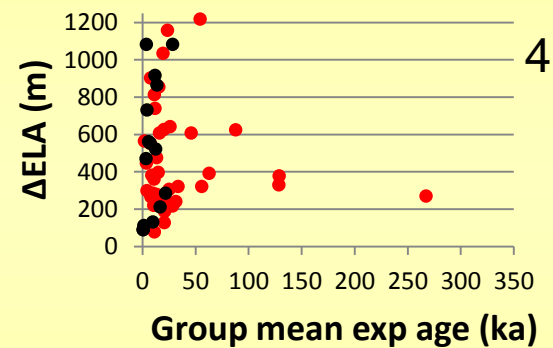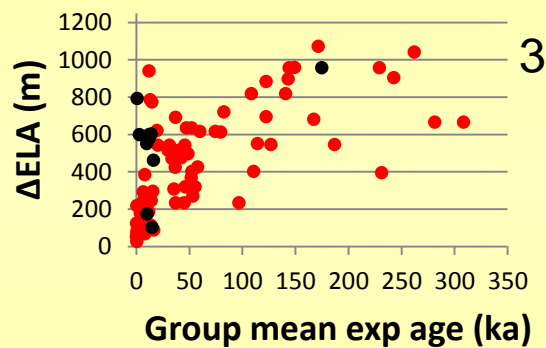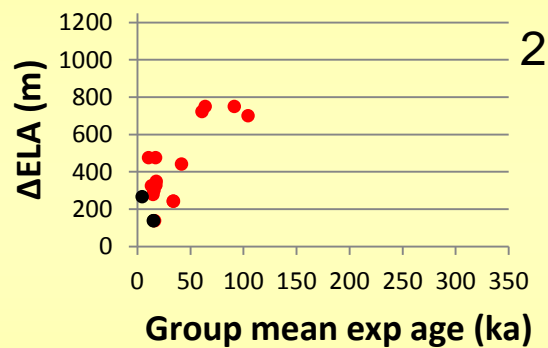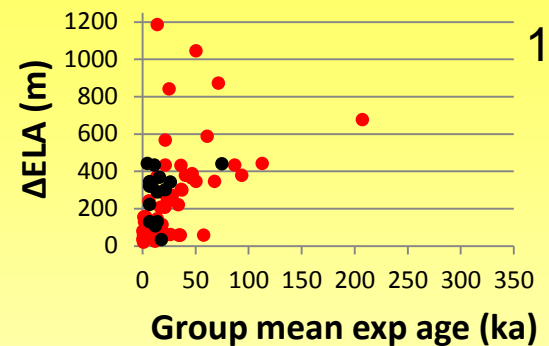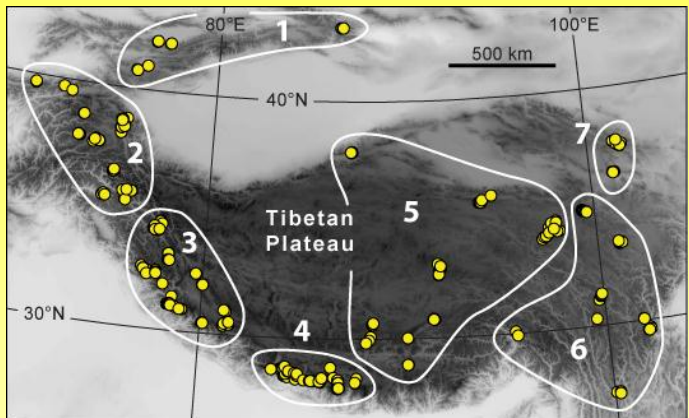
$X_R^2 < 2$
$X_R^2 \geq 2$

Assuming simple ΔELA-temperature relationship with lapse rate 0.0062°C/m
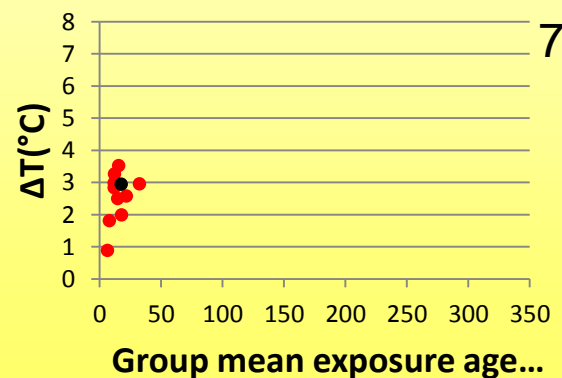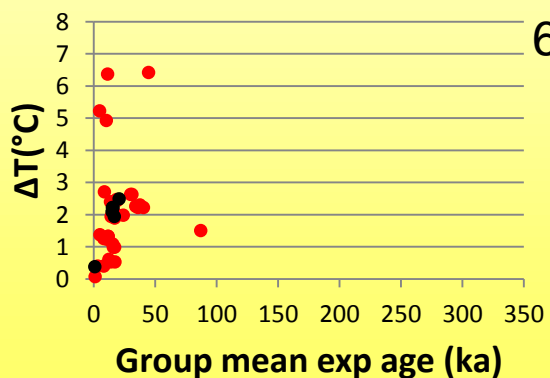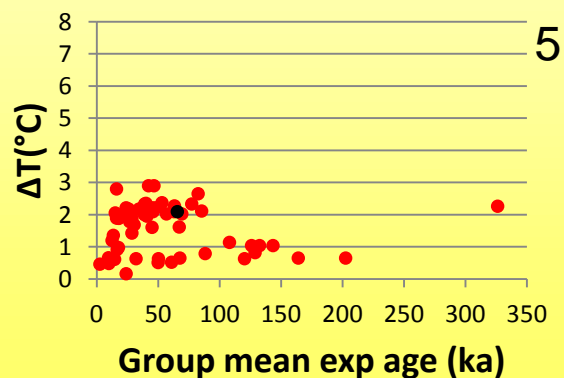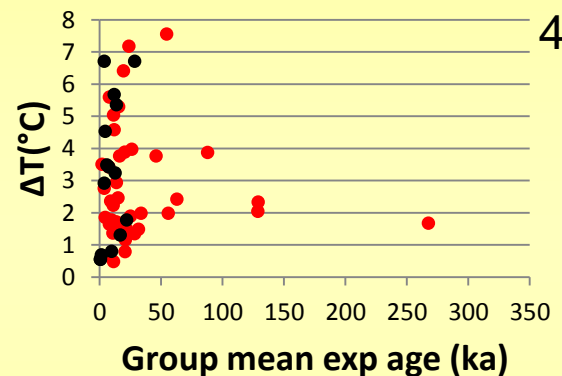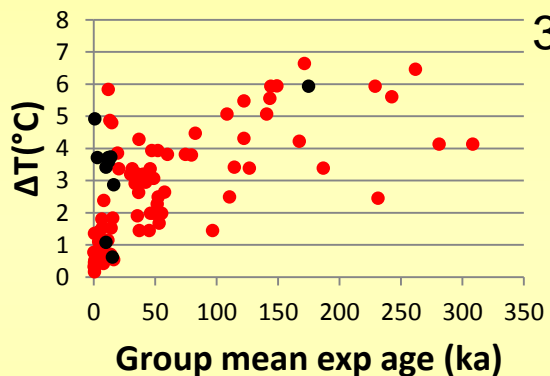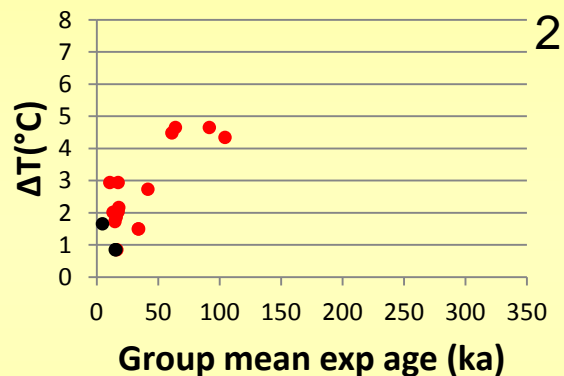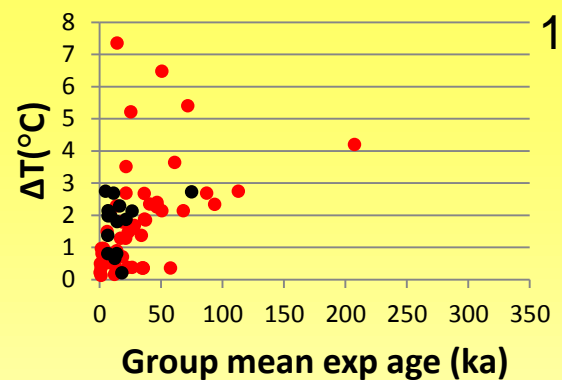
3D glacier modeling paleo-climate reconstructions

-3.0°C
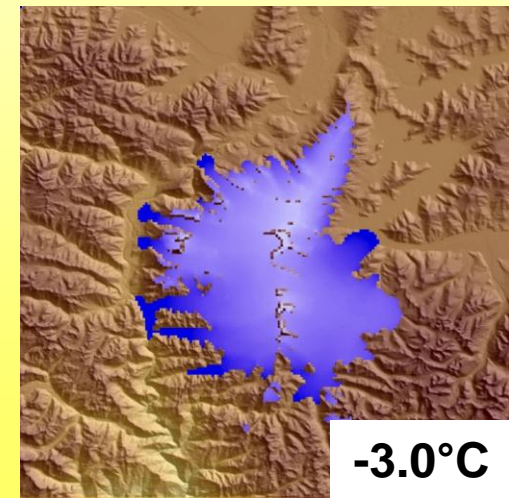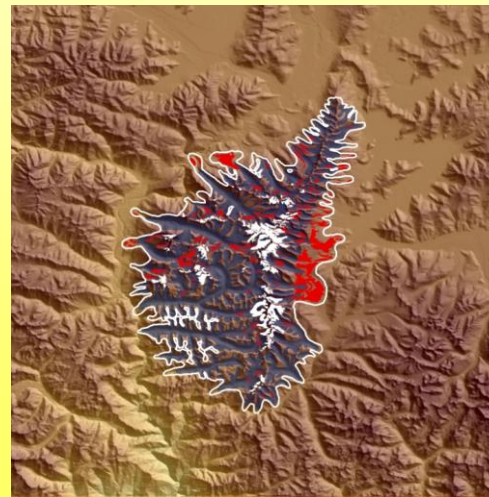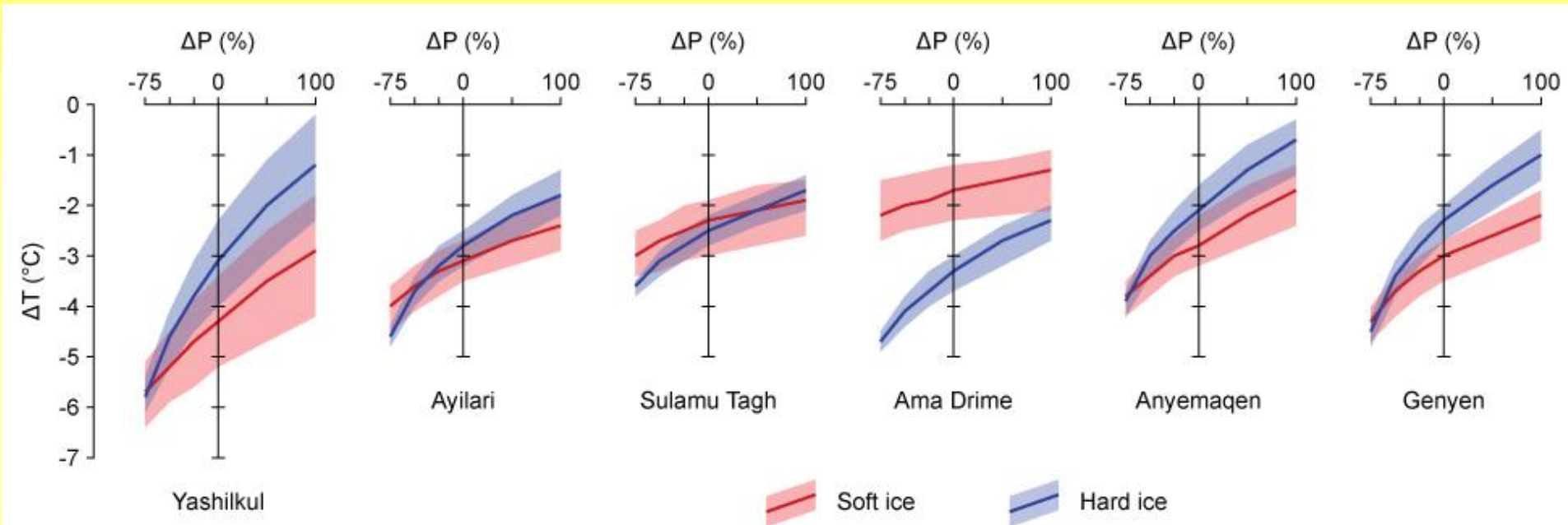
Conclusions

- Highly variable exposure ages and ΔELA estimates

- Large uncertainties in exposure ages – geologic processes have altered the exposure ages of 302 out of 355 sample groups

- ΔELA range from 7 m to 1218 m (mean 360 m; median 320 m)

- Assuming a simple ΔELA-temperature relationship, past glacial climates were 0-7.6°C cooler than today (mean 2.2°C; median 2.0°C)

Thank you!