New surface exposure age data using cosmogenic radionuclides ^{10}Be and ^{14}C to constrain the age of the last deglaciation in the Retezat Mts, Southern Carpathians, Romania

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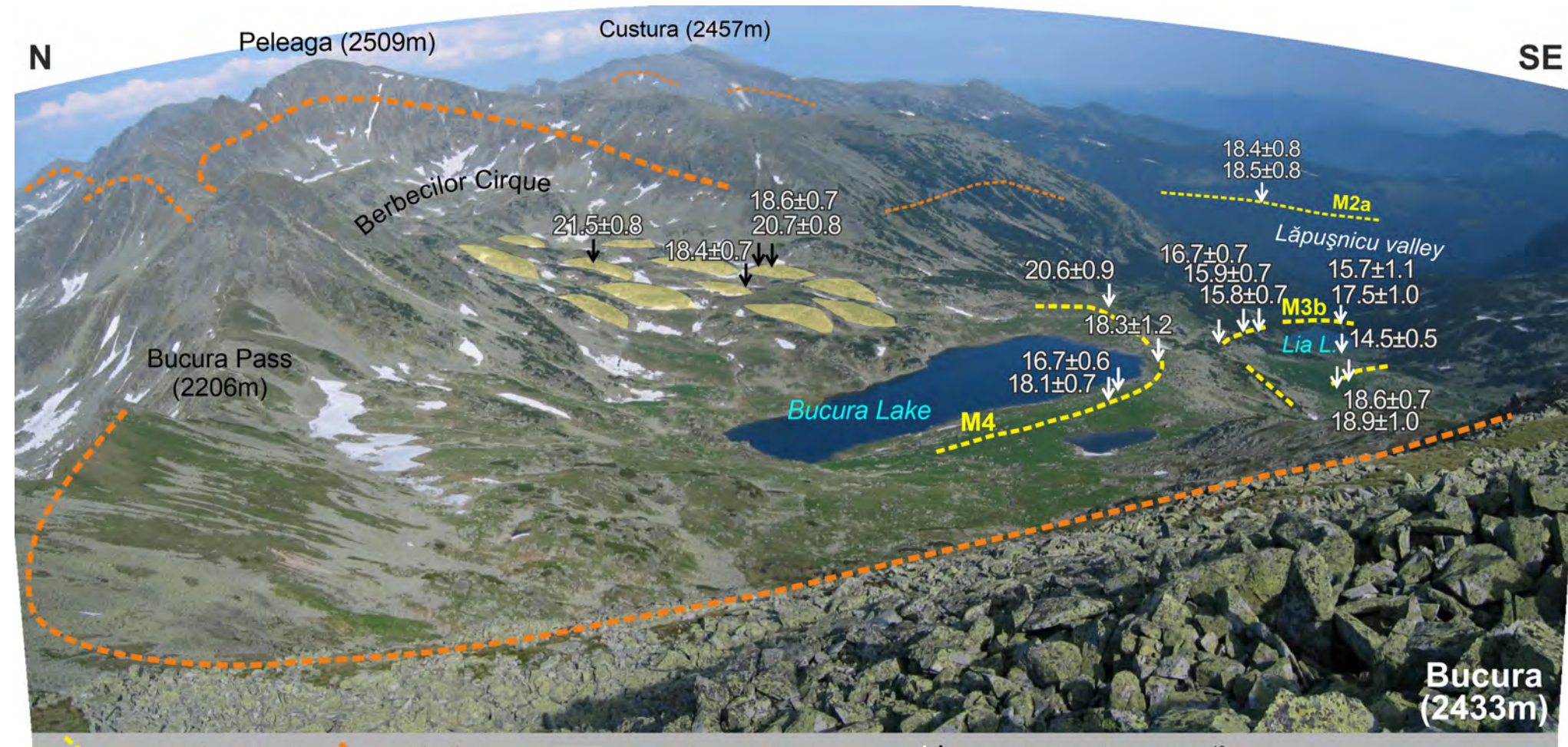
The study area: the Retezat Mts

Peak elevations reaching 2500 m a.s.l.
Extended plateau surfaces around 2000-2200 m a.s.l.
Currently unglaciated.
Former ice caps with glaciers descending in valleys.
Relatively shallow cirques.
Granitic lithology

Previous studies on the northern [1, 2] and southern [3] valleys: Well constrained glacial morphology, four major deglaciation phases.
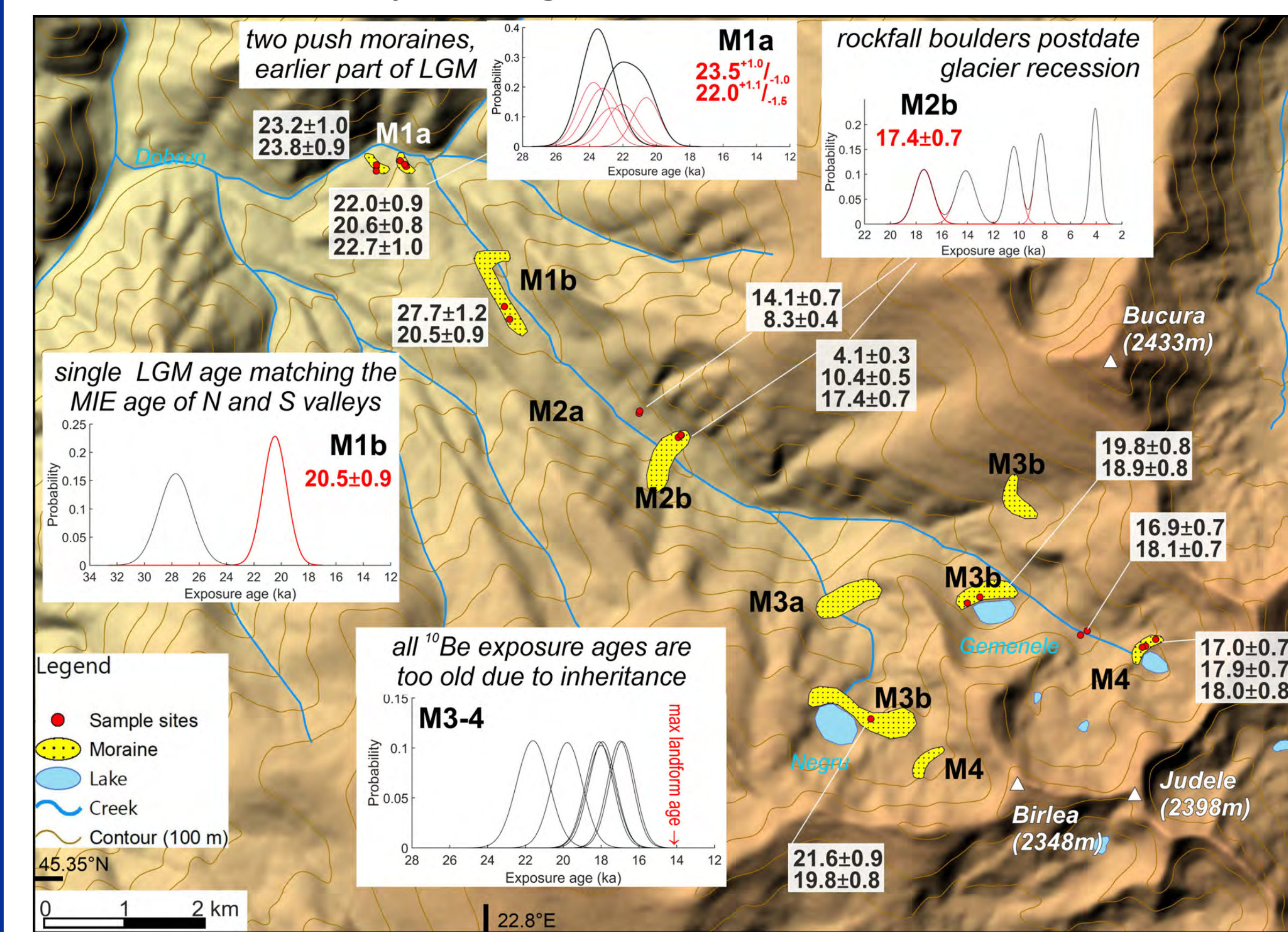
Maximum ice extent:
Glacier area: ~63 km² (south) and 13 km² (north)
Max. ice thickness: ~330 m
Glacier terminations: ~1000-1100 m a.s.l.

Glacial chronology:
Cosmic ray surface exposure dating (SED) using in situ produced ^{10}Be.
Striking effect of inheritance over the ^{10}Be SED data from the southern cirque area.

View of the Bucura and Berbecilor Cirques from the Bucura peak with the glacial landforms.

Objectives

To provide:
- new ^{10}Be SED data from the westen sector of the Retezat Mts.
- new ^{14}C SED data from the moraines in cirques to quantify the amount of inheriance and better constrain the deglaciation ages.
- glacier reconstruction and Equilibrium Line Altitudes (ELA) in the northern, southern and western valley systems

^{10}Be cosmic ray exposure (CRE) dating and the inheritance issue

What worked well: ☺

The ages of the largest and subsequently smaller glacial phases were determined using probability density functions of individual ^{10}Be CRE ages of each moraine generation, the outliers being discarded.

The derived chronologies implied maximum ice extent (MIE) coinciding with the LGM and glacier recession with several stillstands or short re-advances during the Lateglacial.

However, above a certain elevation something „went wrong" ☹
in both the southern and western valleys:

Despite the sampled morphologies were considered as pertinent, **in the cirque areas CRE ages are in contradiction with their morhostratigraphic positions:**

Samples provided highly scattered CRE ages up to ~19-27 ka, similar to or older than the lowermost moraines belonging to the MIE.

Distribution of the sample ages in the cirque area:

LGM age range, relevant for the maximum ice extent in the Retezat Mts
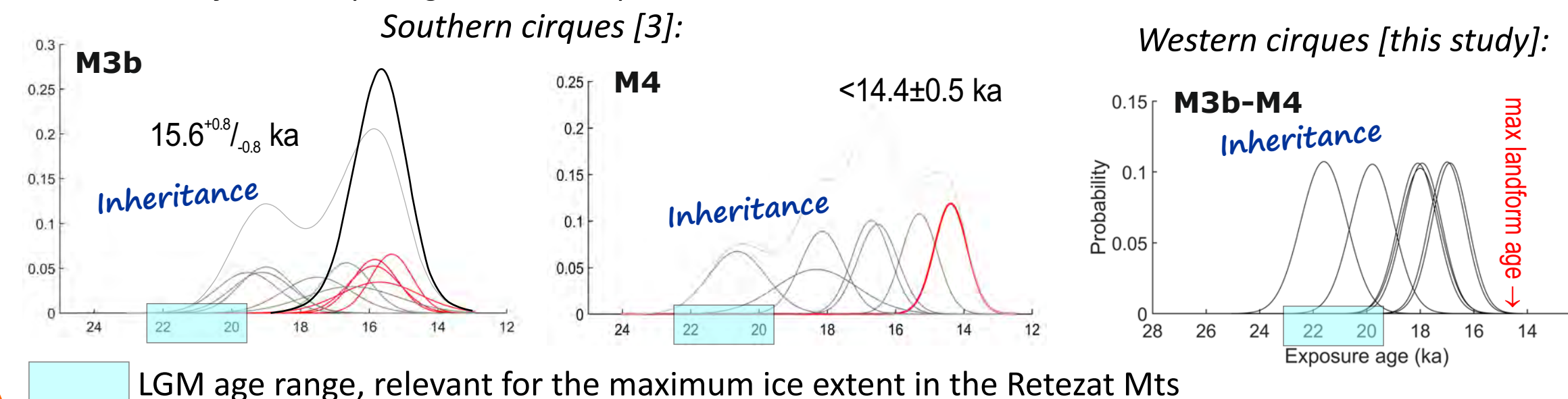
Why we see inheritance only in the cirques of the study area?

During the extended glacial phases the glaciers in the valleys are thicker than in the cirques. Besides, the cirques are well above the ELA and thus, tend to be cold-based with no considearble glacial erosion for most of the glaciation [2].

In the valleys, closer to the ELA glaciers are more much erosive, therefore
→ the erosion depth in the cirques is small, while in the valleys erosion is deep
→ removes enough rock to reset the cosmogenic nuclide clock
→ no inheritance → ^{10}Be ages provide the true age of the landform.

In the cirques the glaciers are erosive only during last phases of glaciation → shallow erosion →SED ages show old bias due to inheritance.

If **L > e** inherited cosmogenic nuclides from a previous interglacial are present in the rock

Surface exposure age determination results

two push moraines, earlier part of LGM **M1a**
rockfall boulders postdate glacier recession **M2b** 17.4±0.7

23.2±1.0 / 23.8±0.9 M1a
M1a 23.5+1.9/−1.8 22.0+1.9/−1.8

22.0±0.9 / 20.6±0.8 / 22.7±1.0 M1b
27.7±1.2 / 20.5±0.9
14.1±0.7 / 8.3±0.4 **Bucura (2433m)**

single LGM age matching the MIE age of N and S valleys **M1b** 20.5±0.9

4.1±0.3 / 10.4±0.5 / 17.4±0.7
19.8±0.8 / 18.9±0.8 M3b
16.9±0.7 / 18.1±0.7 M2b

all ^{10}Be exposure ages are too old due to inheritance **M3-4**

17.0±0.7 / 17.9±0.7 / 18.0±0.8 M4
21.6±0.9 / 19.8±0.8 **Birlea (2348m)** **Judele (2398m)**

Legend
- Sample sites
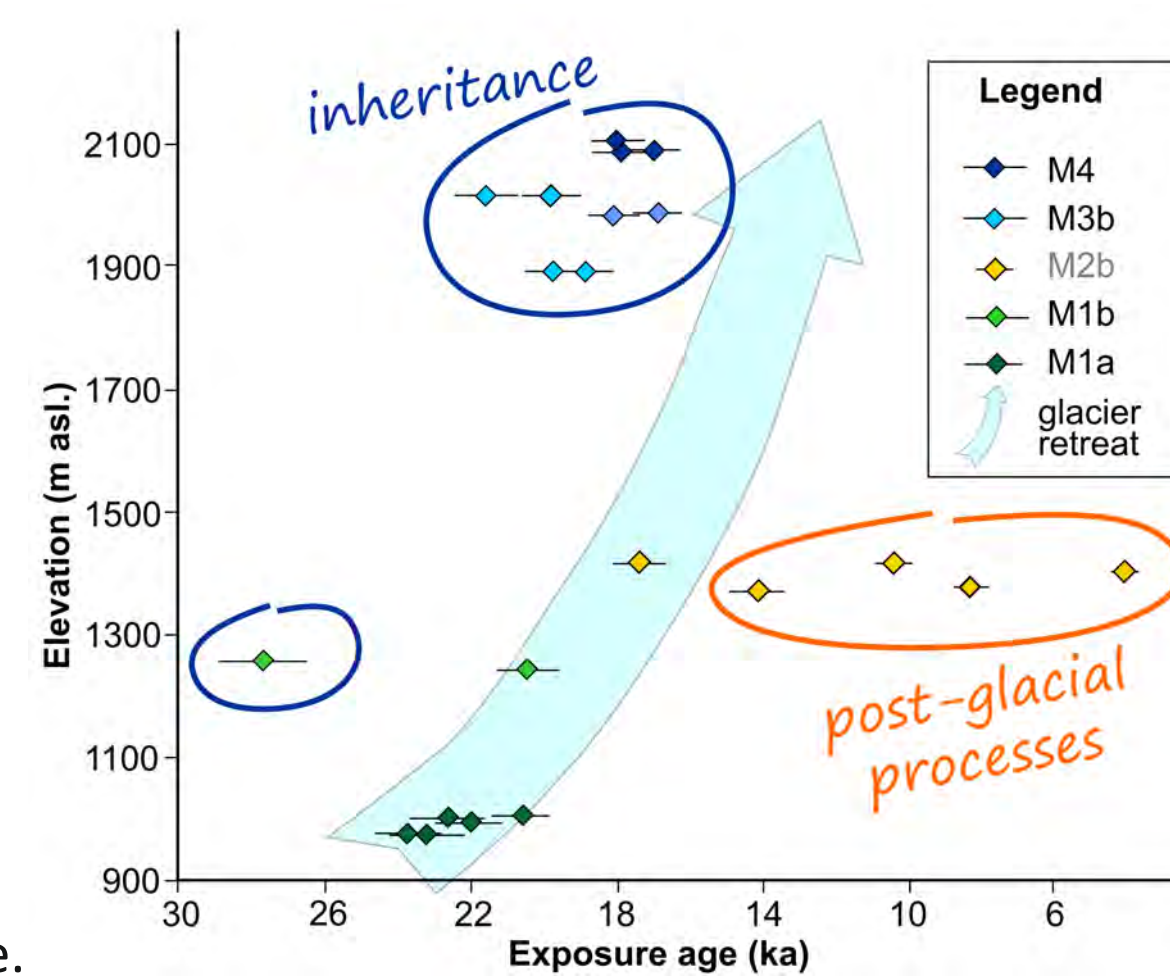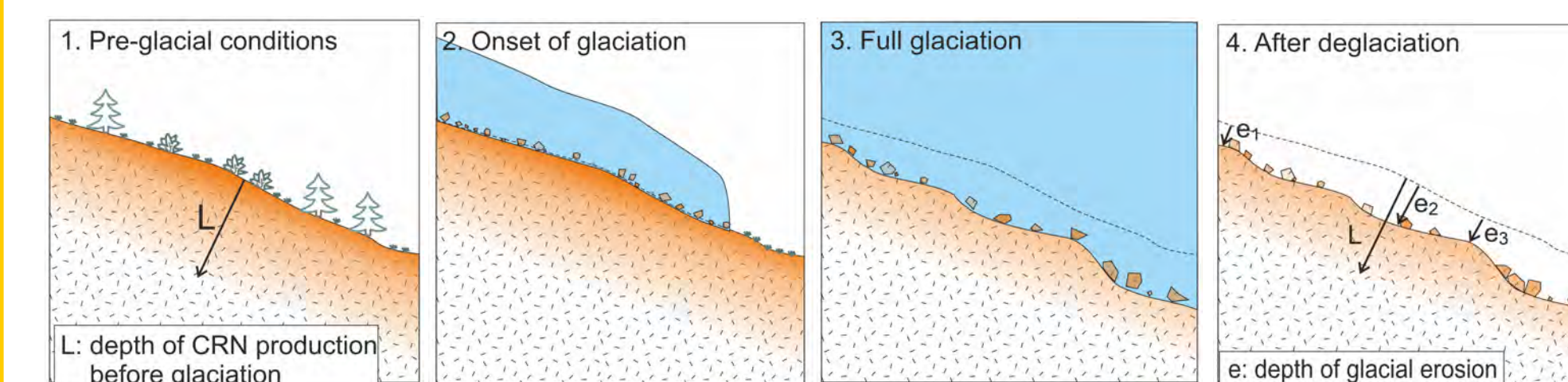- Moraine
- Lake
- Creek
- Contour (100 m)

Glacial landforms, ^{10}Be sample locations and SED results in the Zlătuia-Dobrunu valley.

^{10}Be results

- Several deglaciation phases sampled in the western, Zlătuia-Dobrunu valley.
- Multiple phases of the LGM could be distinguished for the first time in the Retezat Mt.
- In the cirque area, all ages are affected by of inheritance, which hindered direct age determination of these deglaciation phases

Legend
M4 / M3b / M2b / M1b / M1a / glacier retreat

^{14}C results

Unfortunately the ^{14}C results are not yet available.

## Glacier reconstruction and Equilibrium Line Altitude calculation

The **shape and extent of the paleo-glaciers** at the subsequent phases of deglaciation were reconstructed considering the mapped glacial landforms, like lateral and frontal moraines, trimlines and valley topography using a 10 m horizontal resolution digital elevation model (DEM), assisted by 3D imagery provided by GoogleEarth and field experience.

The **paleo-equilibrium line altitudes** were estimated for the different deglaciation phases using an ArcGIS toolbox [4], applying the Accumulation-Ablation Balance Ratio (AABR 1.6) method [5]
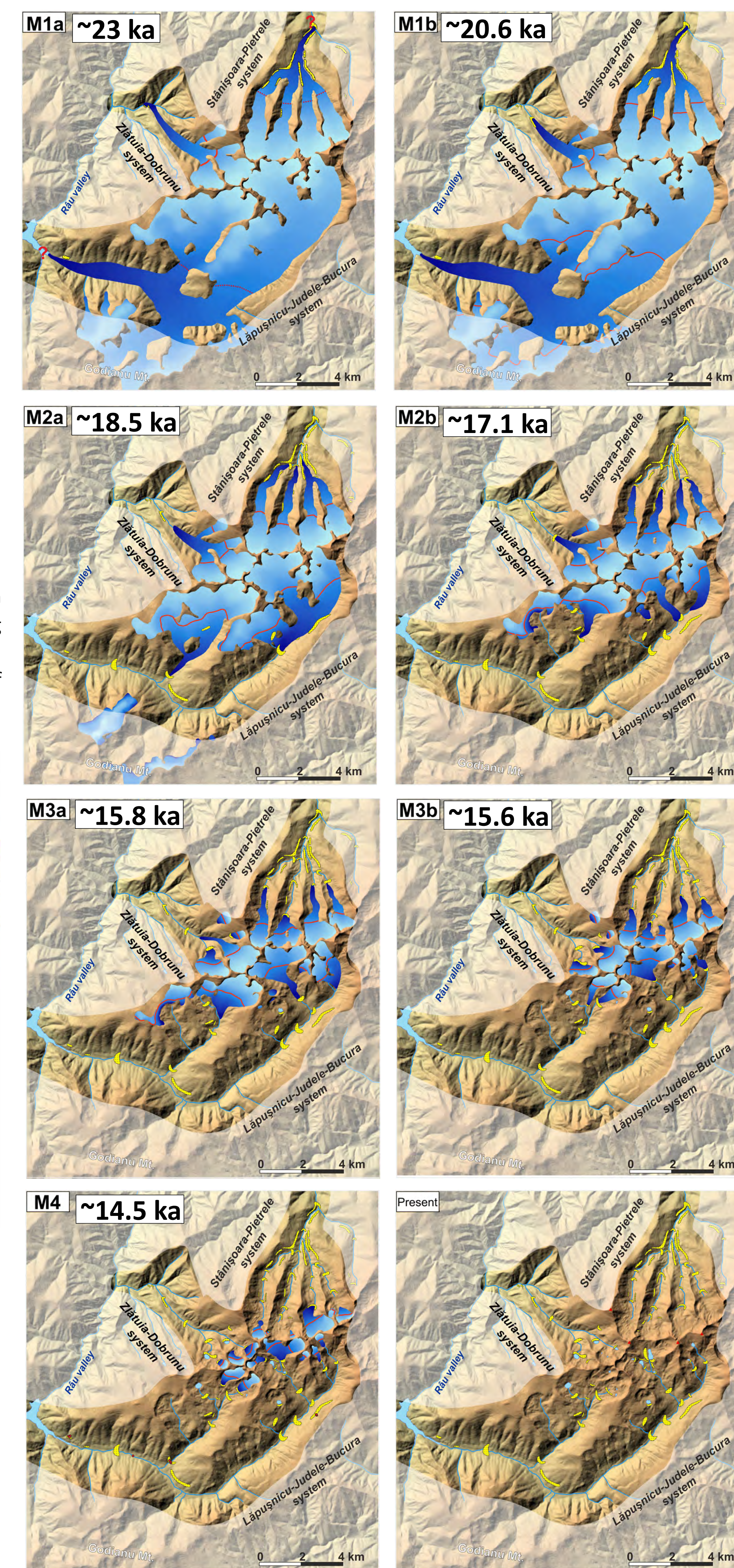
Results and conclusions

Glacier reconstruction and ELAs

- The maximum ice extent coincides with the LGM in the western valleys as well.
- Novel SED ages confirmed the presence of two phases of glacier advance in the LGM (M1a and M1b). The ice covered area is ~6 km².
- During the LGM, the ELA in the southern valleys was ~100 lower than in the northern and western valleys. This may refer to southerny moisture transport direction diring the maximall glaciations.
- During Lateglacial glacier recession, the difference of the ELAs across the valleys of diverse aspect cannot be observed any more.
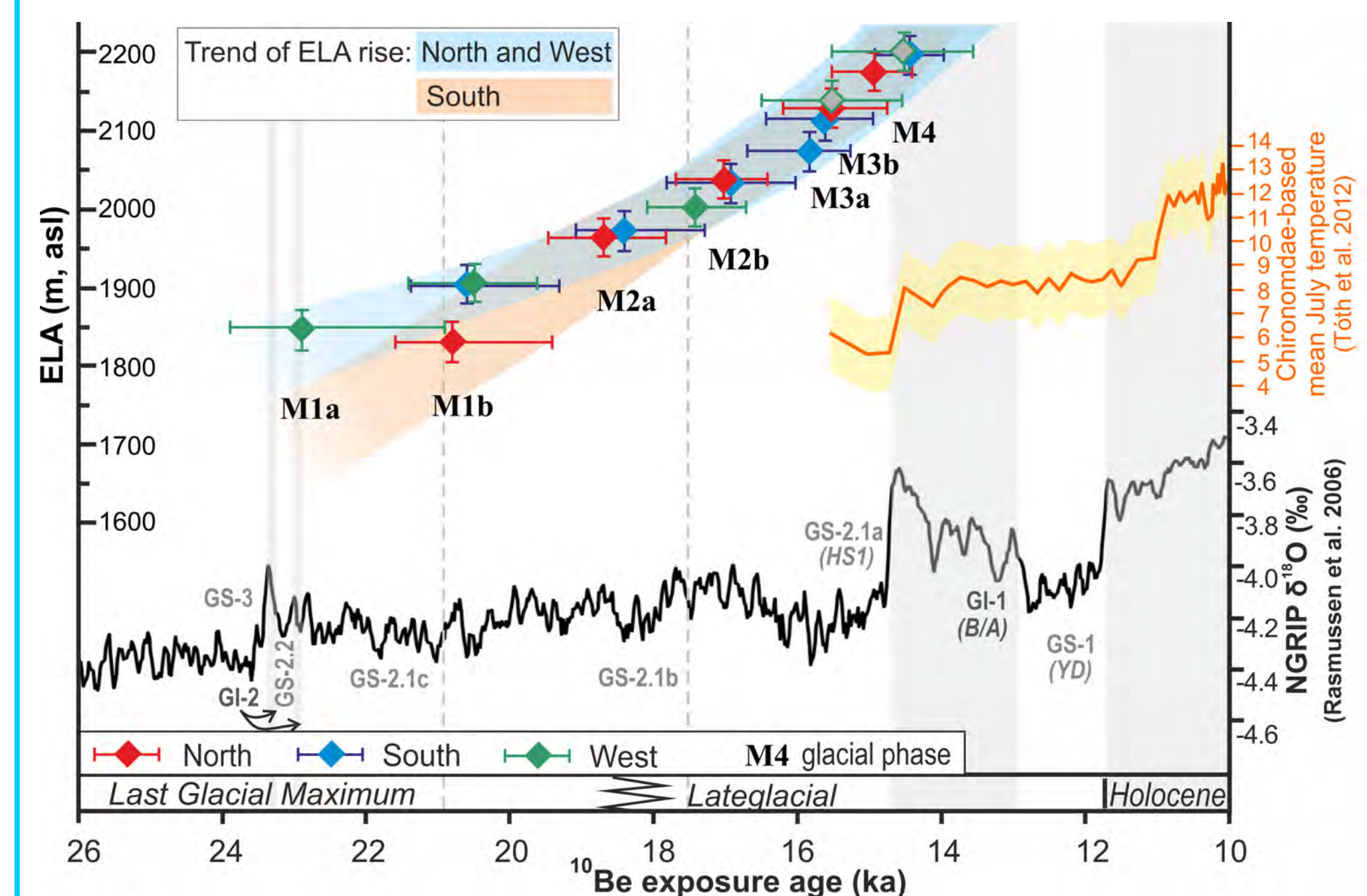
Surface exposure dating

- Until the glaciers are extended in the valleys the CRE ages are well clustered, and provide morpho-startigraphically consequent ages.
- The ^{10}Be SED of the moraines in the shallow cirques is hindered by significant amount of inherited ^{10}Be both in the southern and western valleys. The amount of inheritance will be possible to quantify using an independent time constraints to determine the age of the deglaciation.
- We expect the ^{14}C SED results…

M1a ~23 ka | M1b ~20.6 ka
M2a ~18.5 ka | M2b ~17.1 ka
M3a ~15.8 ka | M3b ~15.6 ka
M4 ~14.5 ka

↑ South-north transect along the Lăpușnicu and Bucura valleys to the Piertele valley, with the most probable ^{10}Be exposure ages of the subsequent deglaciation phases [3]

References

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[2] Ruszkiczay-Rüdigeret al., 2016. Revised deglaciation history of the Pietrele-Stânișoara glacial complex, Retezat Mts, Southern Carpathians, Romania. Quat. Int. 415, 216–229.

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