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New apatite fission track thermochronology data from the Siberian Permian-Triassic Traps

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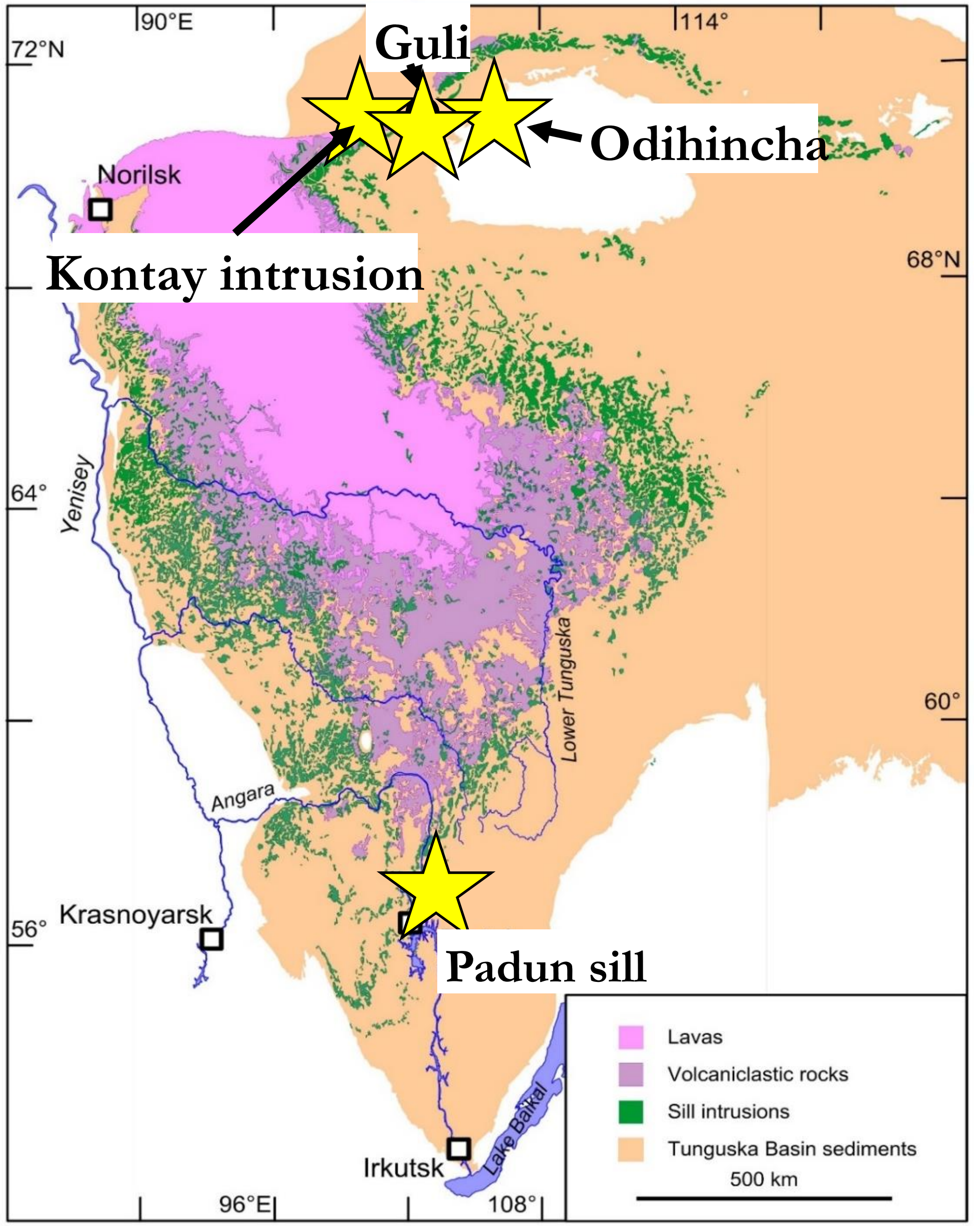
Aims of fission track analysis

- Reconstruct tectonic-thermal evolution of the studied intrusive massifs within the North and South of the Siberian platform during the last 250 million years

- Comparing with existing chronological data to further constrain time of magmatic activity's total duration within the Siberian platform

Study area



- The studied magmatic complexes are located within the Siberian Traps Large Igneous Province

Svensen et al., 2009

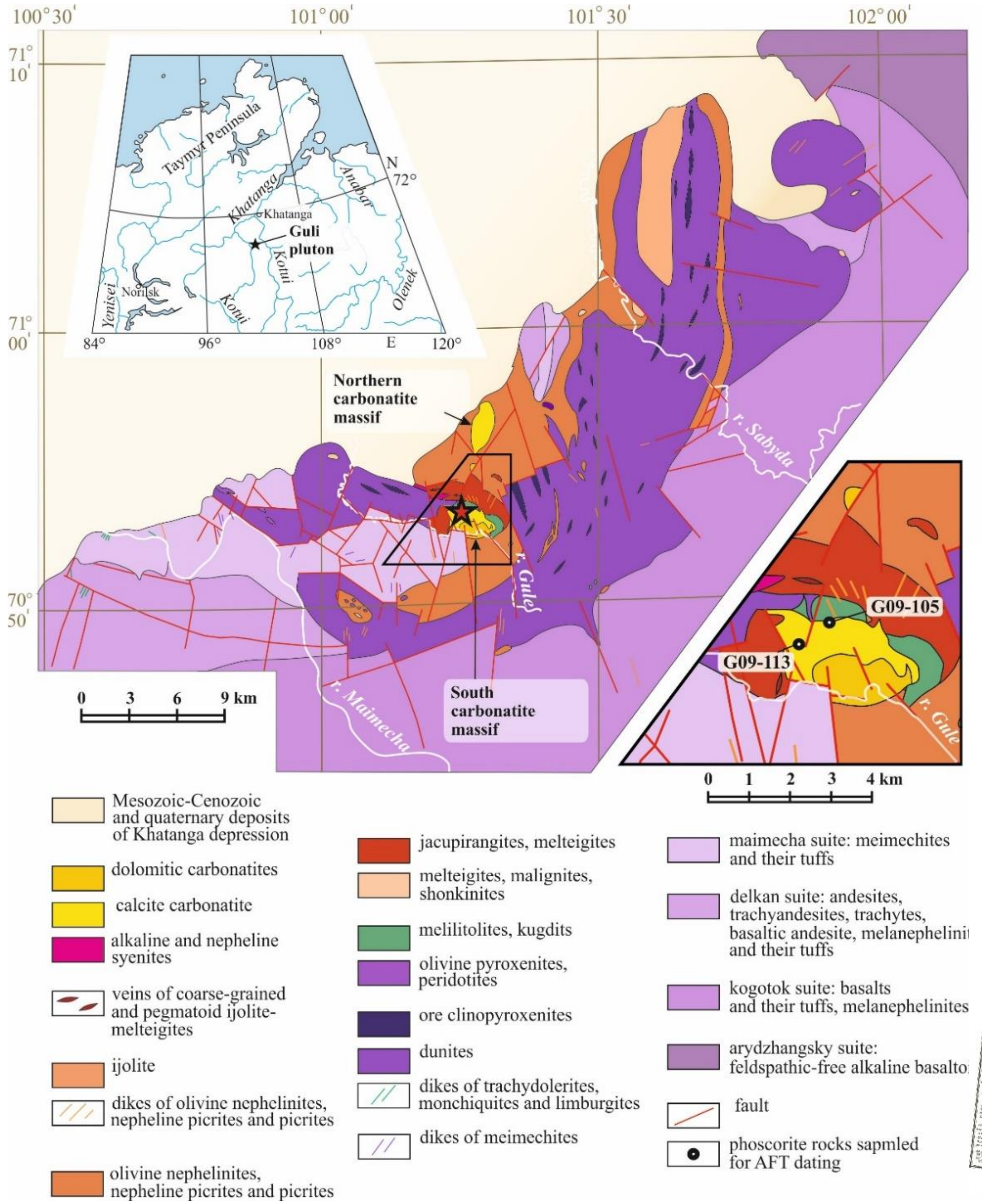
Previous geochronological work within the Siberian Traps Large Igneous Province

- **U-Pb**: **~252.0-251.3 Ma** (the main the Siberian trap province's phase of magmatic activity) (Ivanov, 2011)

- **Ar/Ar** ages: **~240 Ma** (Ivanov, 2011)

- A single definition of a apatite fission track age **(AFT)** – **222-185 Ma** (Rosen et al., 2009)

Guli pluton



250.8±1.2 Ma, U-Pb, baddeleyite (Malich et al., 2015)

250.2±0.3 Ma, U-Pb, baddeleyite (Kamo et al., 2003)

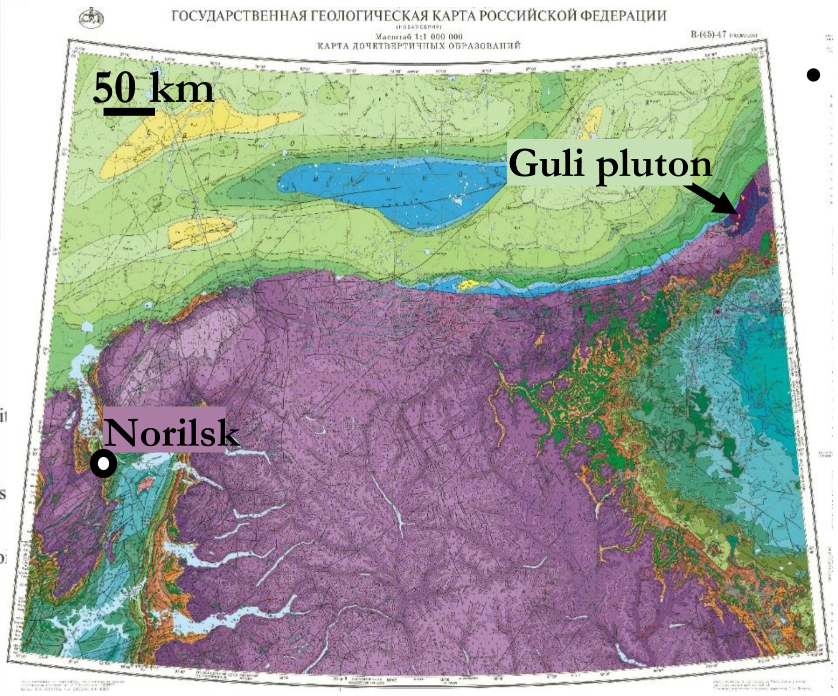
250.1±2.9 Ma, Th-U-Pb, thorianite (Malich et al., 2015)

251.1±0.3 Ma, U-Pb, zircon (Kamo et al., 2003)

251.7±0.2 Ma, U-Pb CA-TIMS, zircon (Burgess, Bowring, 2015)

250±8.7 Ma, U-Pb (Kogarko et al., 2011)

245±1.2 Ma, Ar/Ar, biotite (Dalrymple at al., 1995)



- Consist of ultramafic rocks of normal alkalinity (dunites, chromitites and magnetite clinopyroxenites), which are cut by a complex of alkaline rocks and carbonatites formed in several phases

(Myshenkova et al., 2020 based on (Egorov, 1991; Geological map…, 1996)

Guli pluton

Southern carbonatite massif

Apatite fission track analysis of three monofractions from two samples was performed

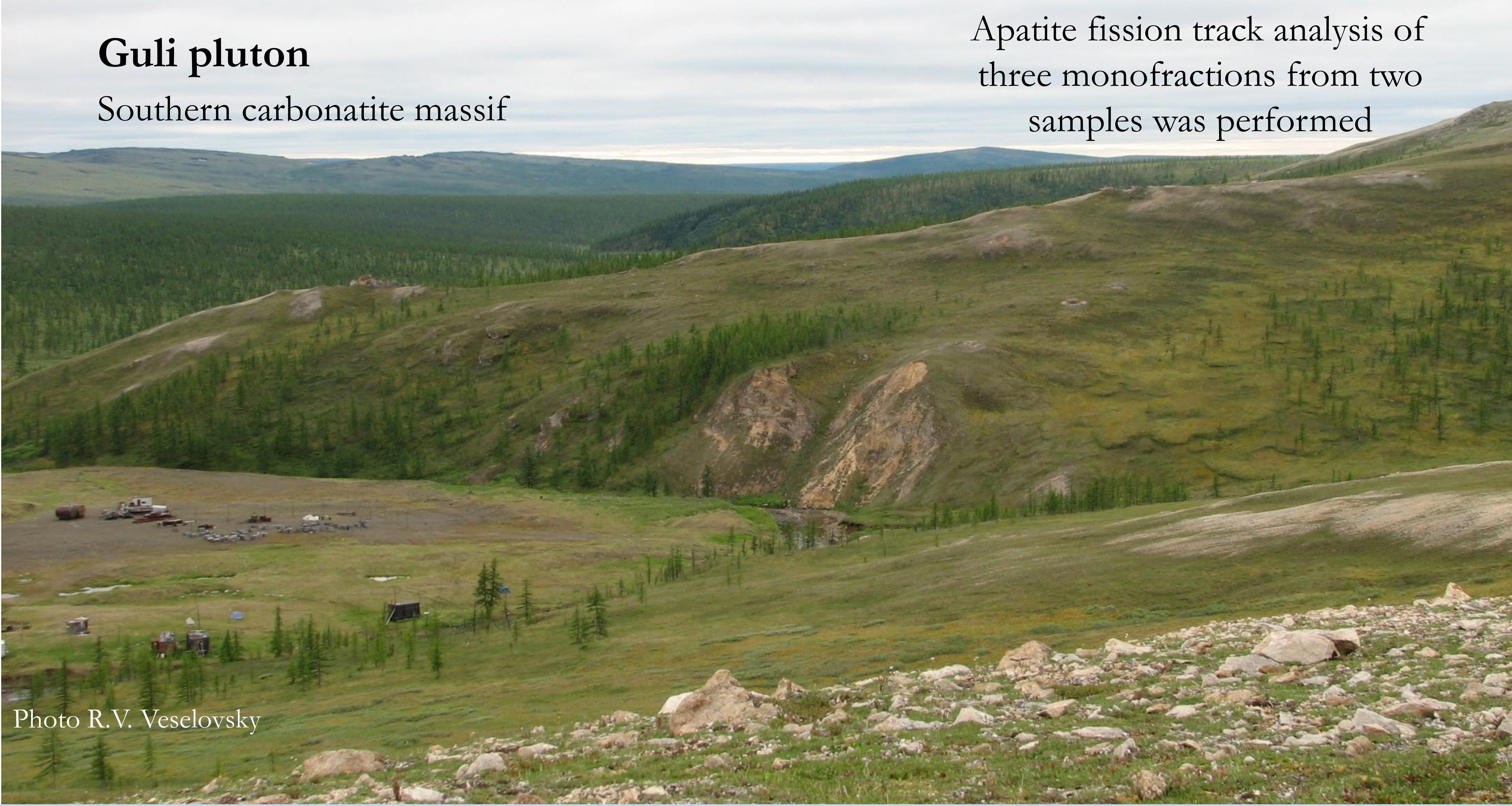
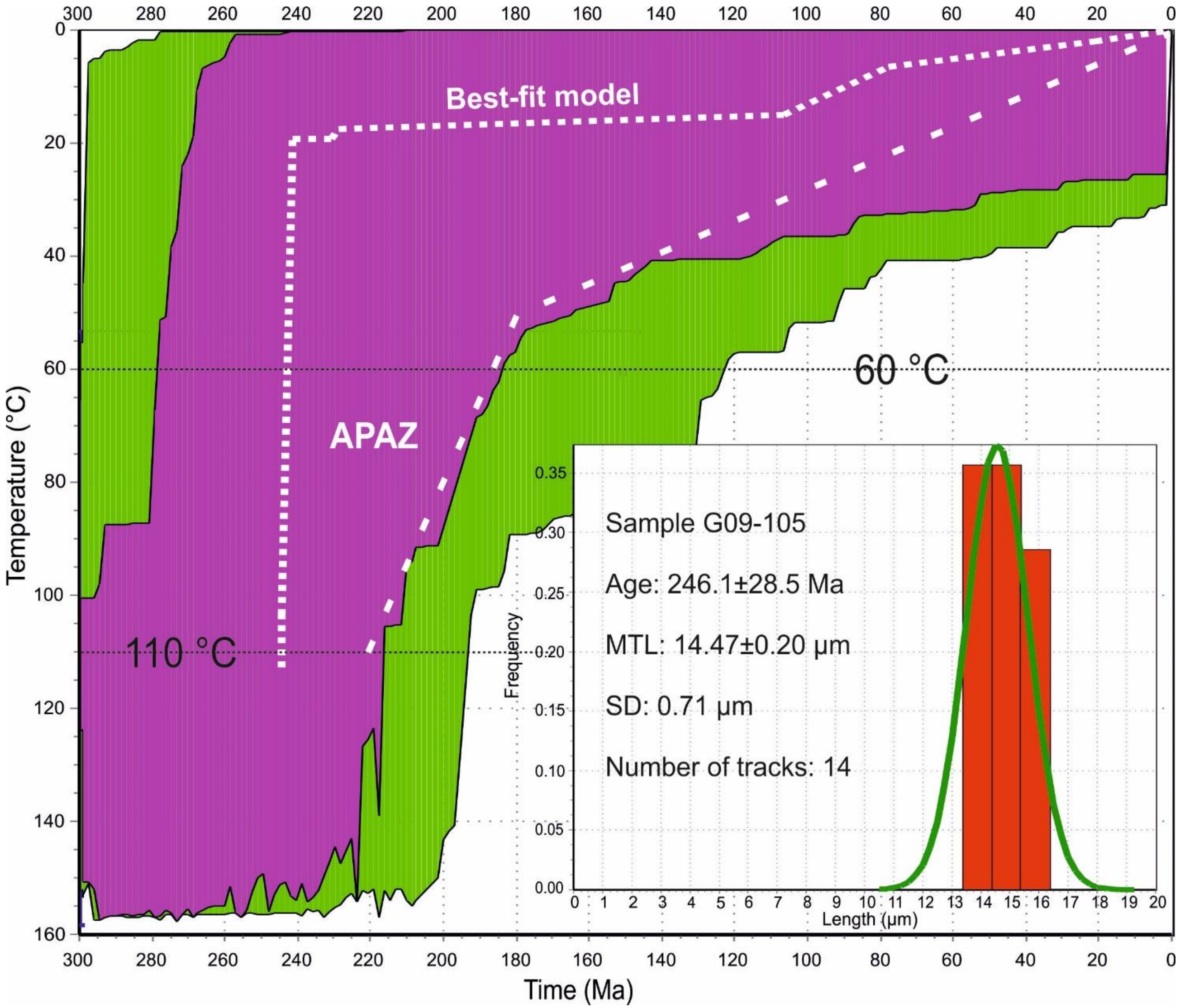


Photo R.V. Veselovsky

Results of thermal history modeling

in the program HeFTy v. 1.8.6 (Ketcham, 2005)



Dating results:
250.1 ± 41.8 Ma
246.1 ± 28.5 Ma
231.2 ± 31.8 Ma

Model № 1

The emplacement of intrusions ca. 250 Ma (U-Pb)

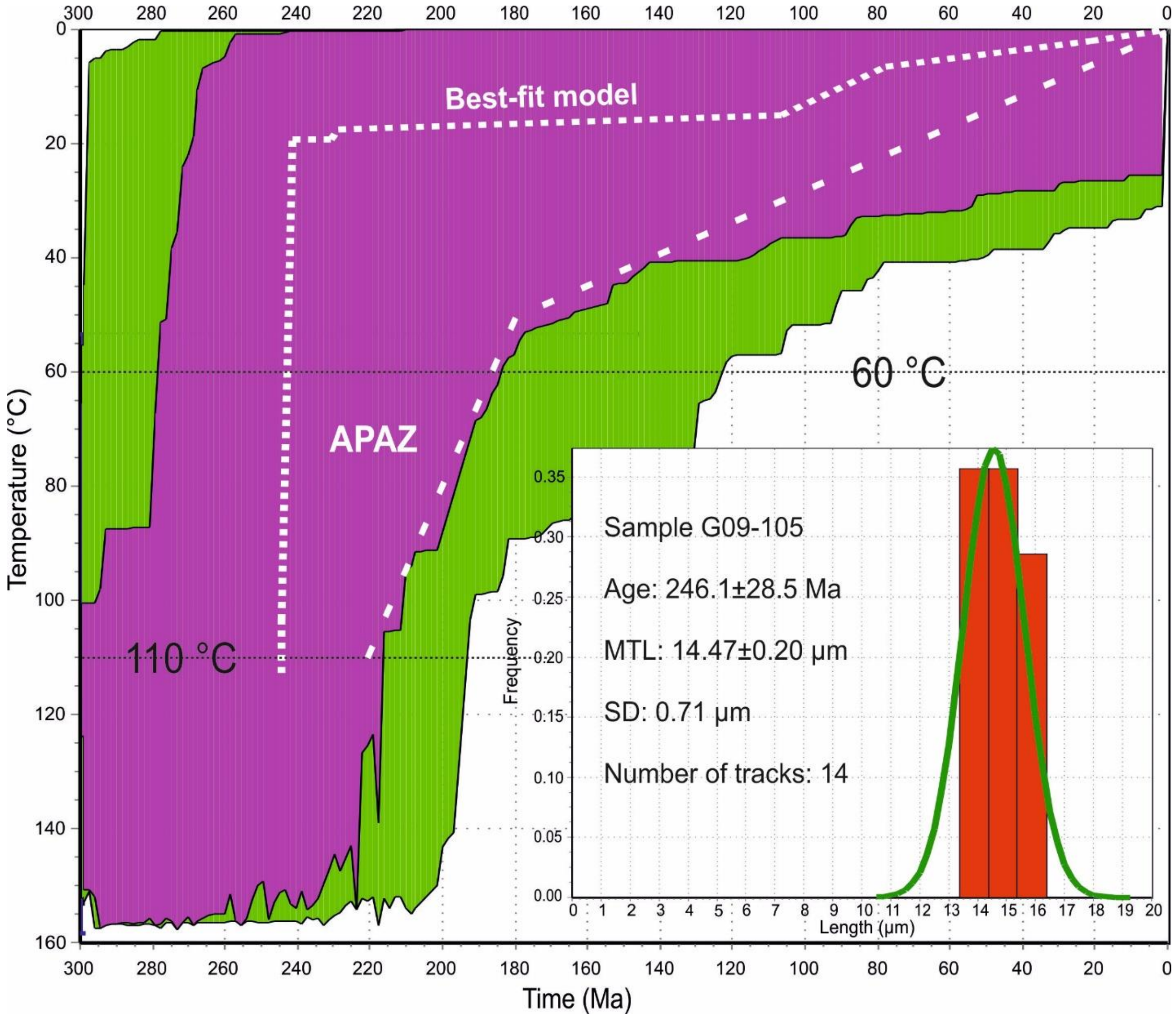
Cooling below ~110°C about 246 Ma (fission track age)

Fast cooling below 60°C (left the apatite partial annealing zone – APAZ)

Green curves are models that cannot be completely excluded from consideration (0.1<p<0.5).
Purple curves are models that best match the formal (hypothetical) model (p>0.5).

Results of thermal history modeling

in the program HeFTy v. 1.8.6 (Ketcham, 2005)



G09-105 ~ 218 Ma

Model № 2

Three reasons for young age:

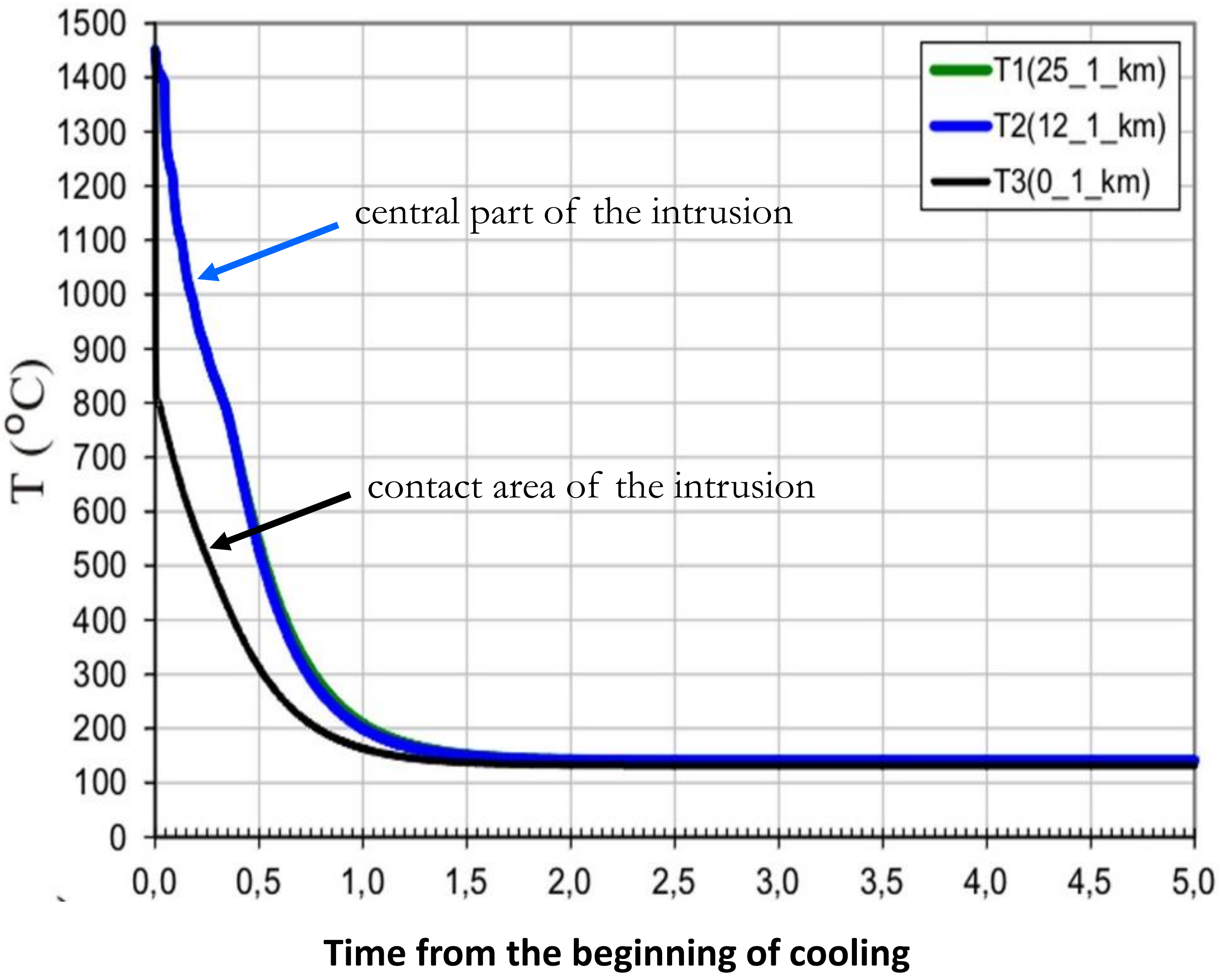
(1) long-term (about 30 Ma) post-magmatic cooling

(2) an episode of endogenous activity that occurred at least in the Maimecha-Kotui province and caused secondary warming above 110°C

(3) burial under a sedimentary (volcanic?) cover ~ 2-3 km, where, with a geothermal gradient increased as a result of trap magmatism (~50°C/km), the temperature is 110°C is quite achievable

Green curves are models that cannot be completely excluded from consideration (0.1<p<0.5). Purple curves are models that best match the formal (hypothetical) model (p>0.5).

Reason 1. Long-term (about 30 Ma) post-magmatic cooling



Result of the computer simulation of the cooling process of the Guli Pluton:

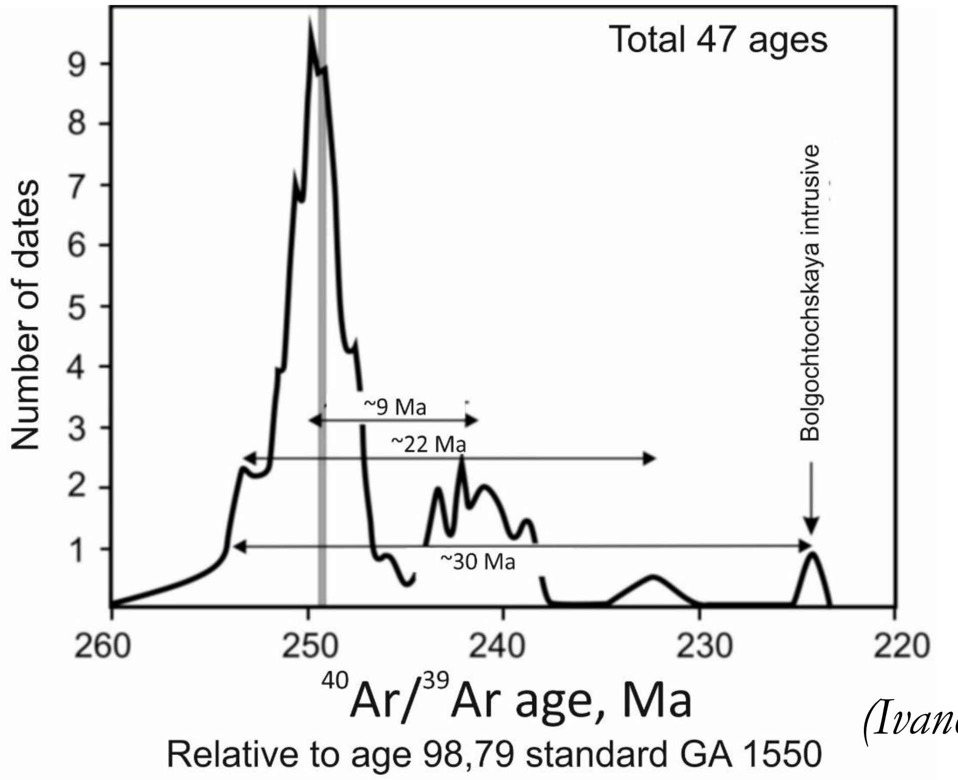
The cooling's duration of the Guli pluton is about 2 Ma, which confirms the rapid cooling below the temperature range of 110-60°C (apatite partial annealing zone)

Parameters:

- Pluton as a cylindrical body with a diameter of 45 km
- Country rocks (from top to bottom)
  1. basalts (2.9 km)
  2. large and small clastic terrigenous (0.14 km) and carbonate (0.96 km) rocks
  3. below the rock of the basement
- The overlying rocks are basalts, 1.5 km thick.

Reason 2. An episode of endogenous activity that caused secondary warming above 110°C

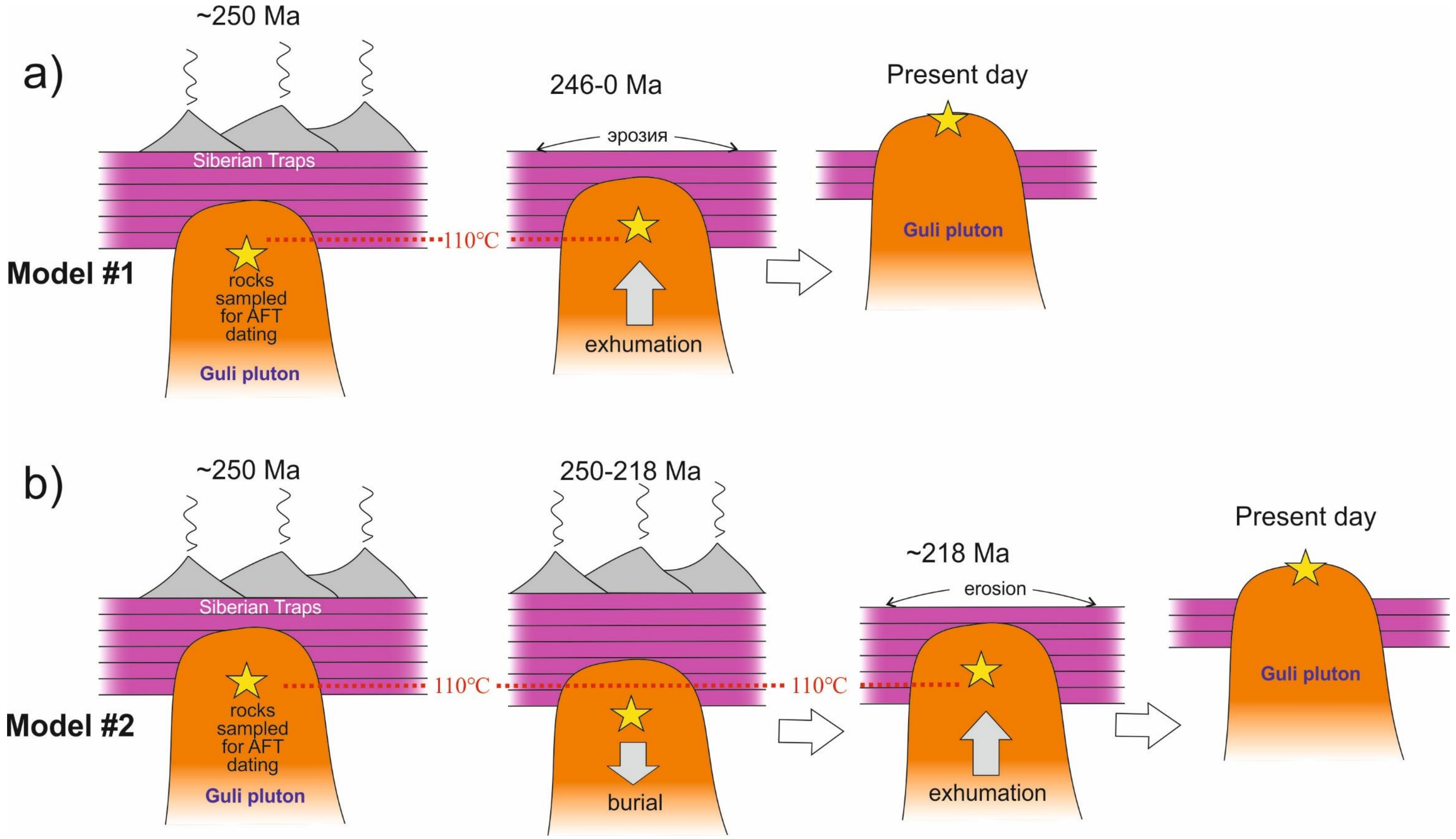
Low-(150-300°C, feldspars) and medium-temperature (300-600°C, micas and amphiboles) Ar/Ar thermochronological definitions for magmatic objects of the Maimecha-Kotui province are few, among them there are almost no dates with ages younger than 240 Ma.



(Ivanov, 2011)

Reason 3. Burial under a sedimentary (volcanic?) cover ~ 2-3 km, where, with a geothermal gradient increased as a result of trap magmatism (~50°C/km), the temperature is 110°C is quite achievable

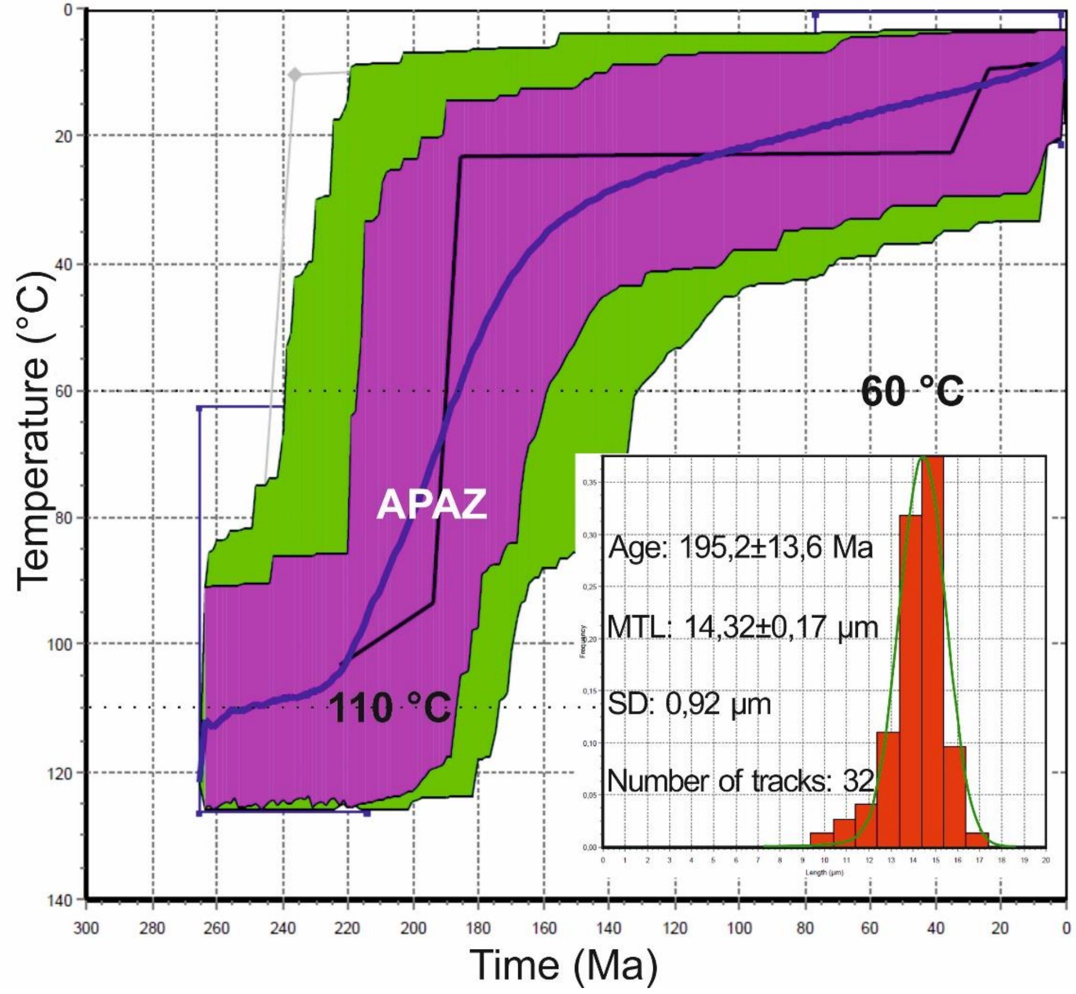
Tectonic-thermal evolution of the Guli massif



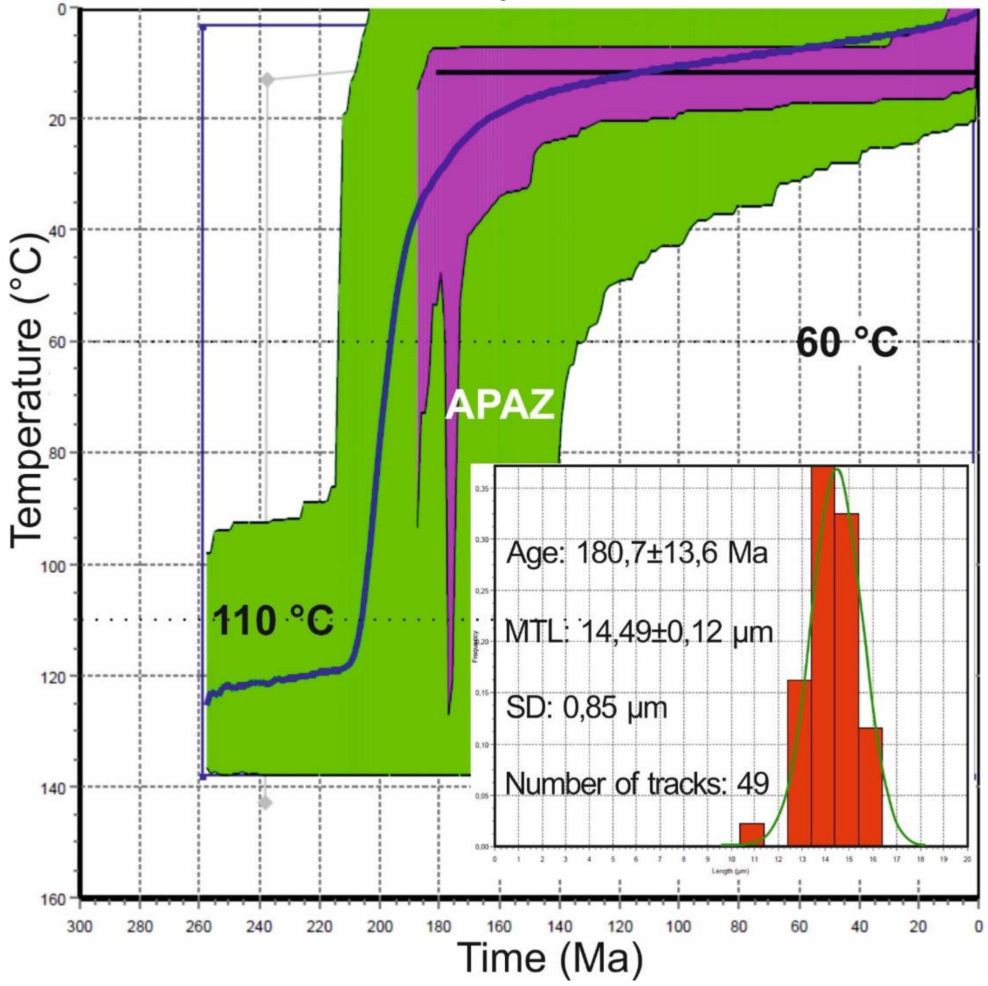
Results of thermal history modeling

in the program HeFTy v. 1.8.6 (Ketcham, 2005)

Padun sill



Kontay intrusion

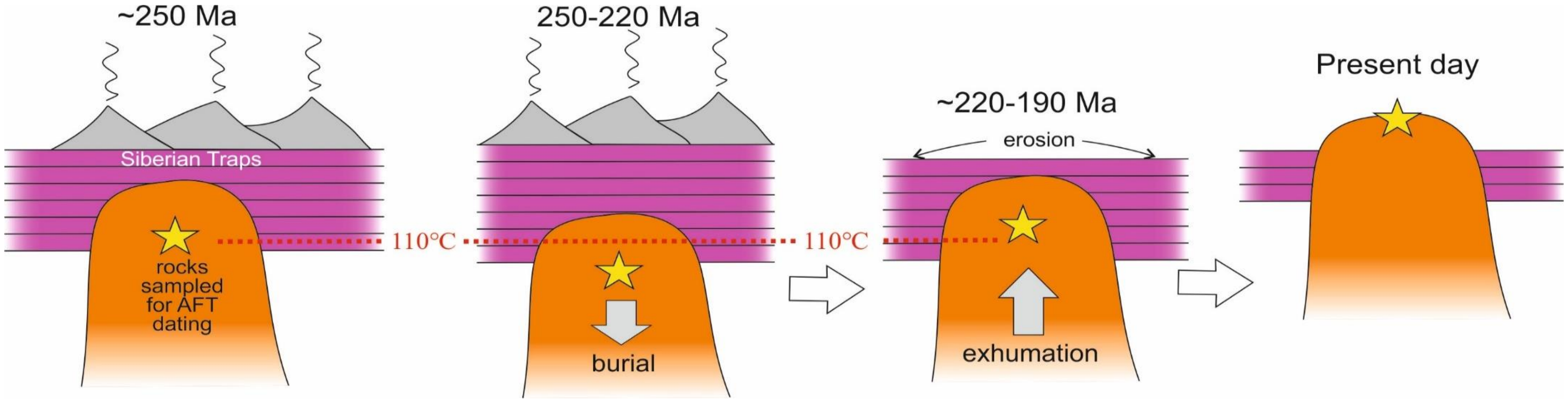


The results of tectonic-thermal modeling for the Padun sill and Kontay intrusion are generally consistent with the result for the Guli pluton.

Conclusions

Thus, we can suppose the following model of tectonothermal evolution of the studied intrusive massifs and, probably, the whole the Siberian platform:

1. the emplacement of intrusions ca. 250 Ma;
2. their burial under a thick sedimentary (volcanic?) cover;
3. regional exhumation and cooling below 110°C about 220-190 Ma.



These results are partly published in Myshenkova M.S., Zaitsev V.A., Thomson S., Latyshev A.V., Zakharov V.S., Bagdasaryan T.E., Veselovsky R.V., 2020. Thermal history of the Guli pluton (north of the Siberian platform) according to apatite fission-track dating and computer modeling. Geodynamics & Tectonophysics 11 (1), 75–87. doi:10.5800/GT-2020-11-1-0464

Acknowledgements: This study is supported by RFBR (grants 18-35-20058-mol_a_ved, 18-05-70094 and 18-05-00590-a), project 0137-2019-0014 and the MSU developing program. The work was performed using the equipment of the Center for the collective use of MSU ultra-high-performance computing resources.

Thank you for your attention!