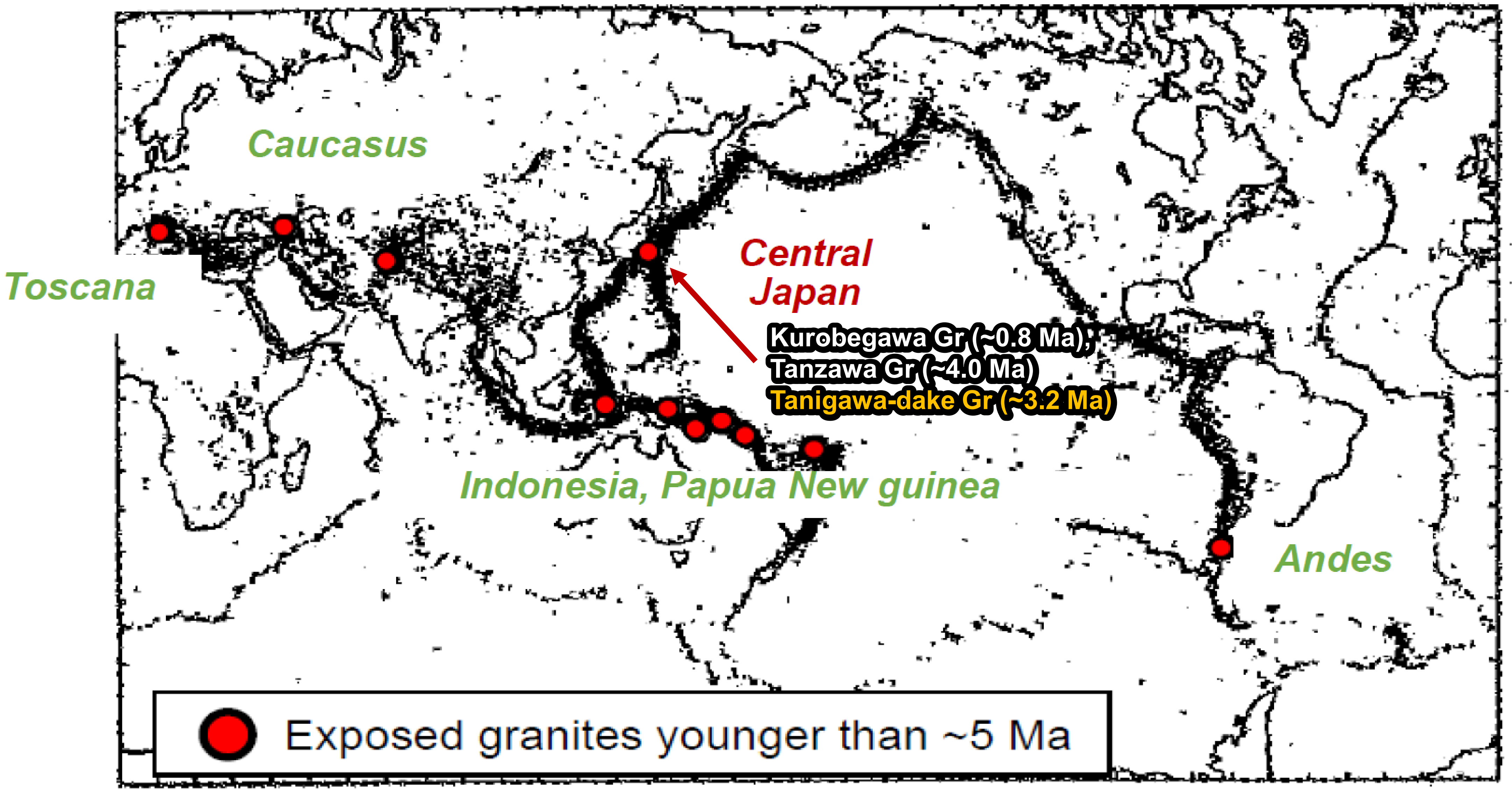
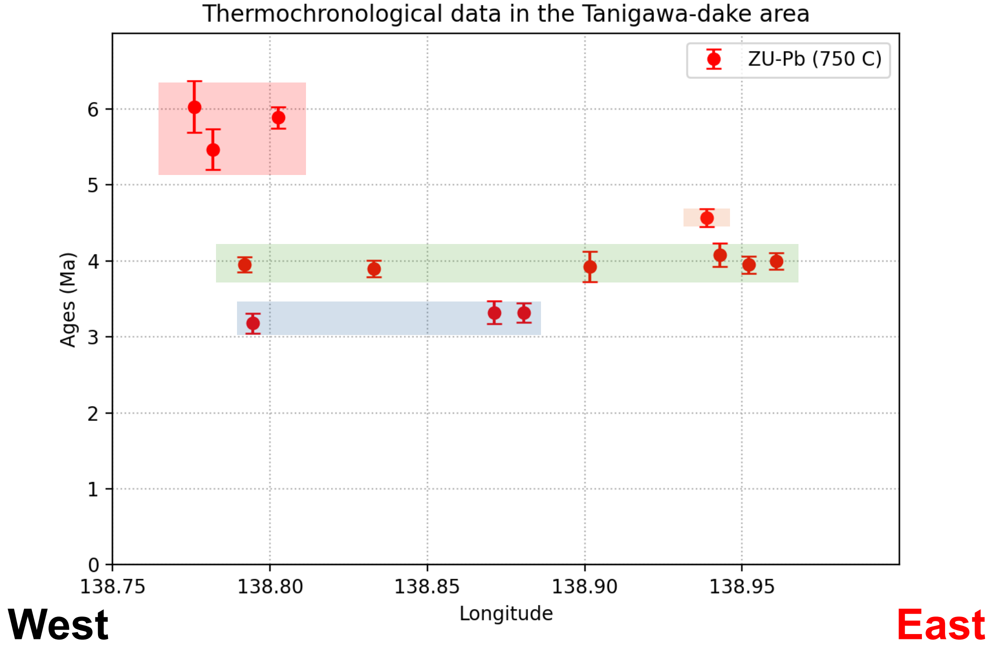
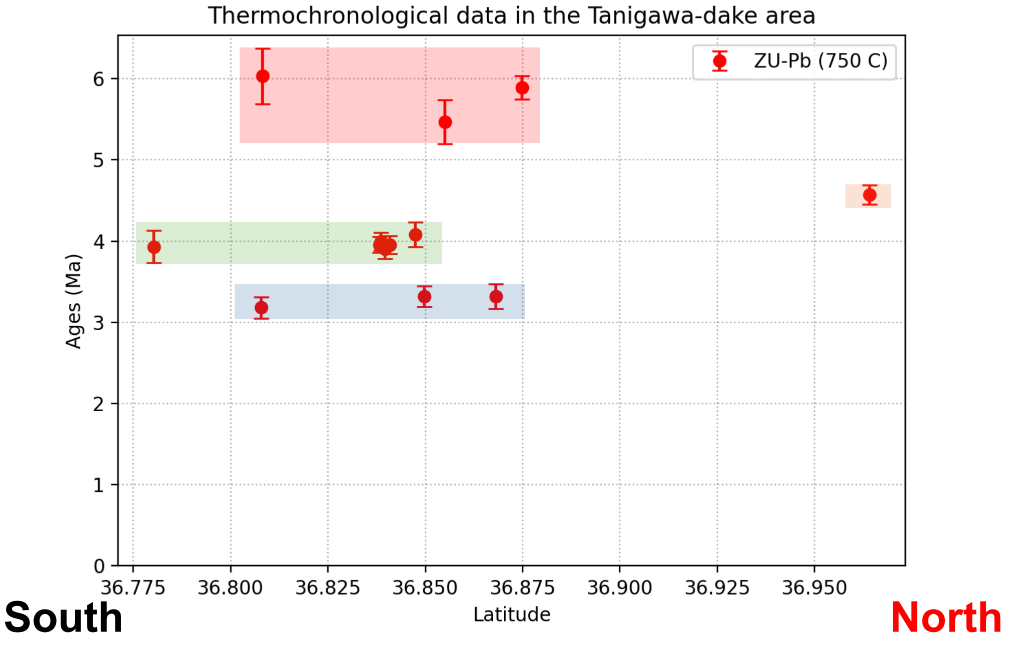
Motivation

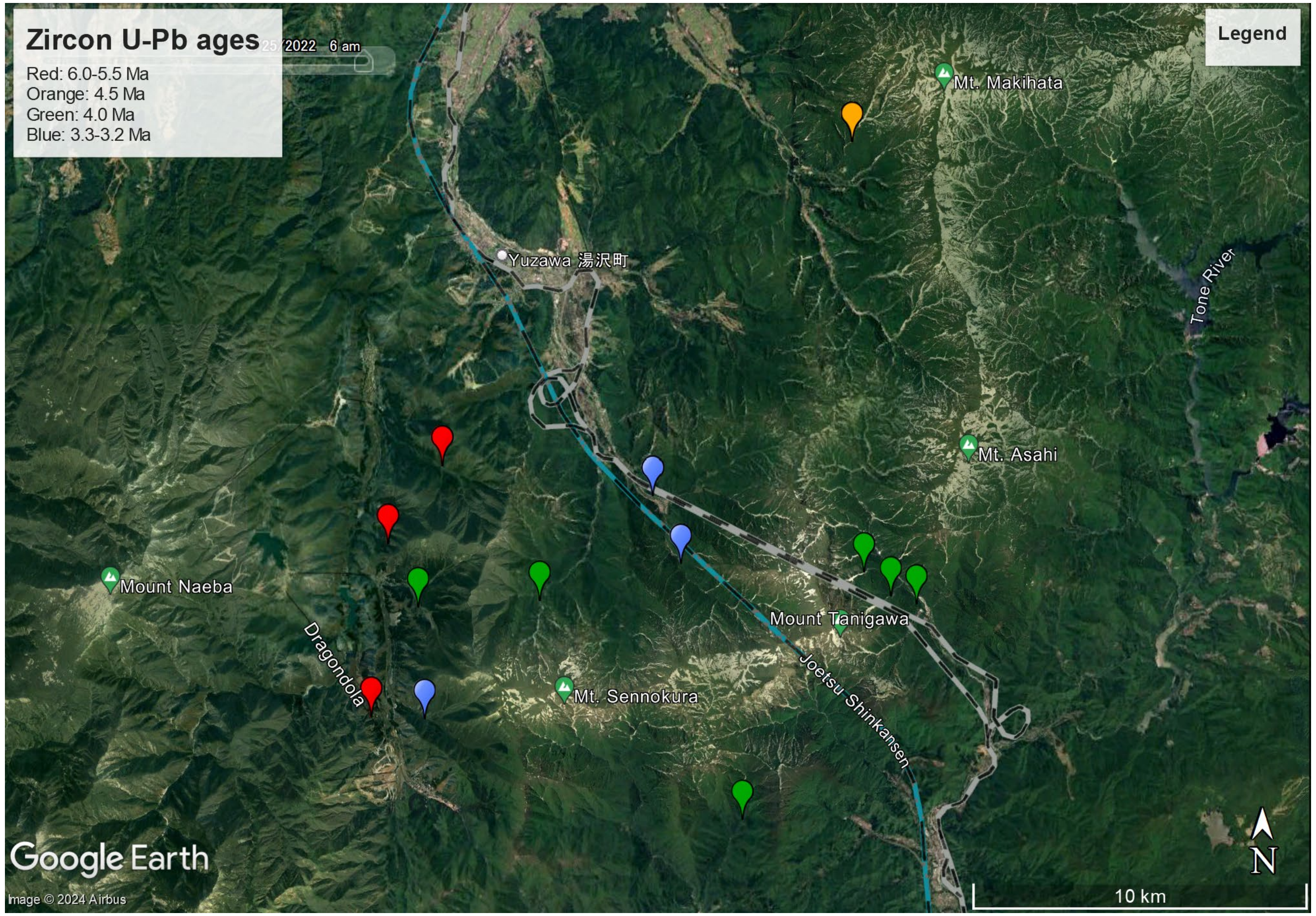


Modified from Harayama (1992)

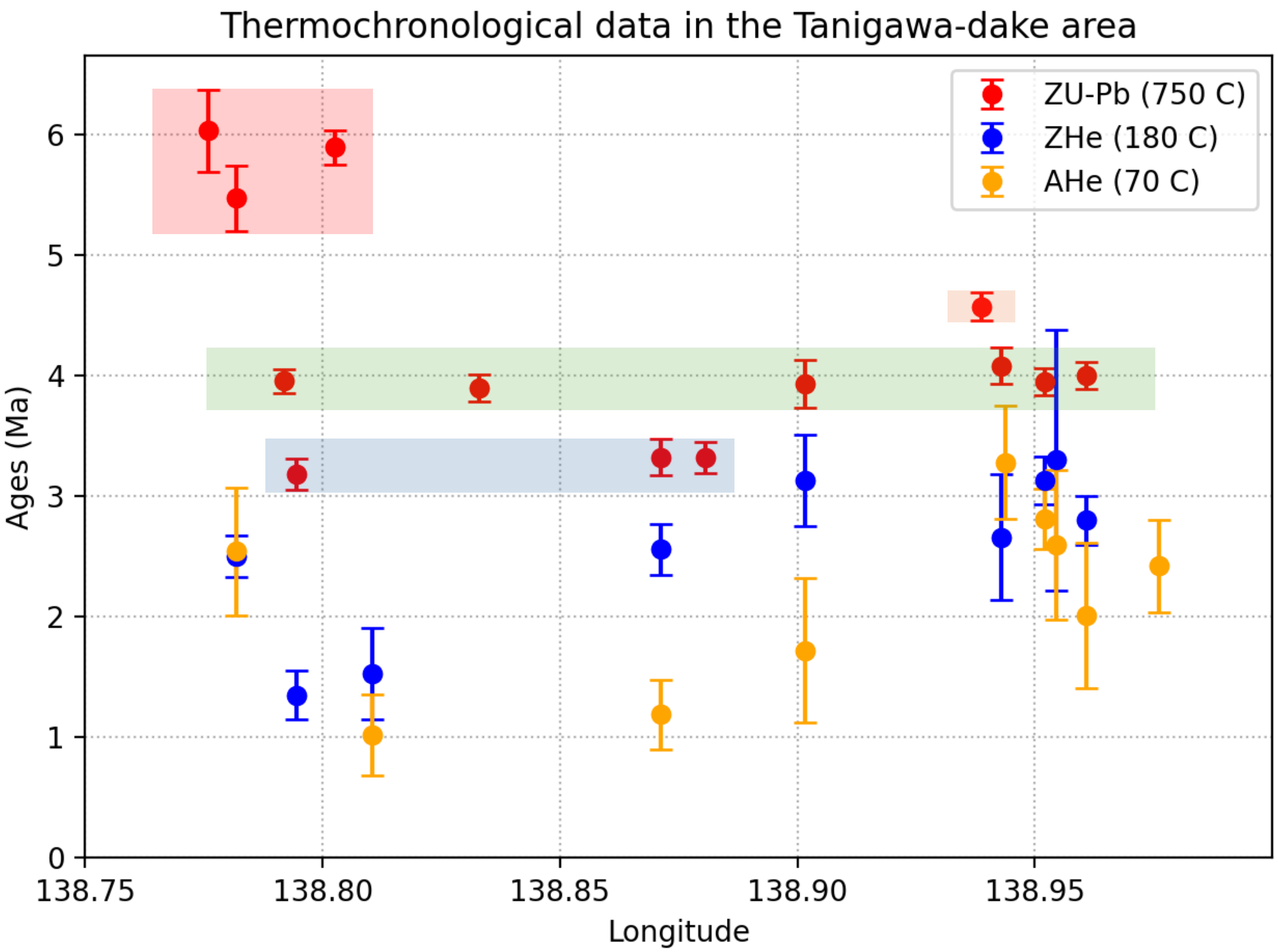
Thermochronological dates



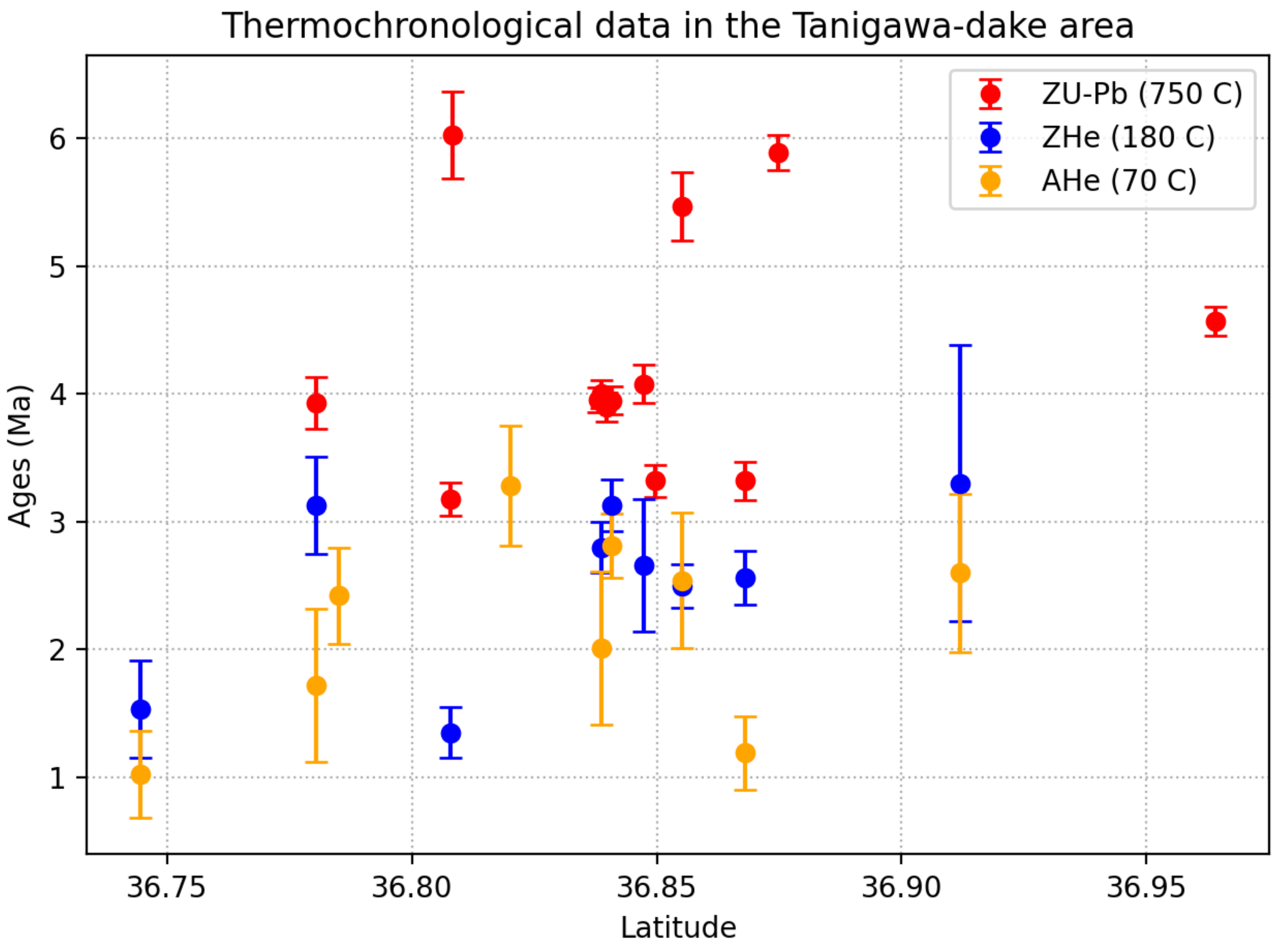




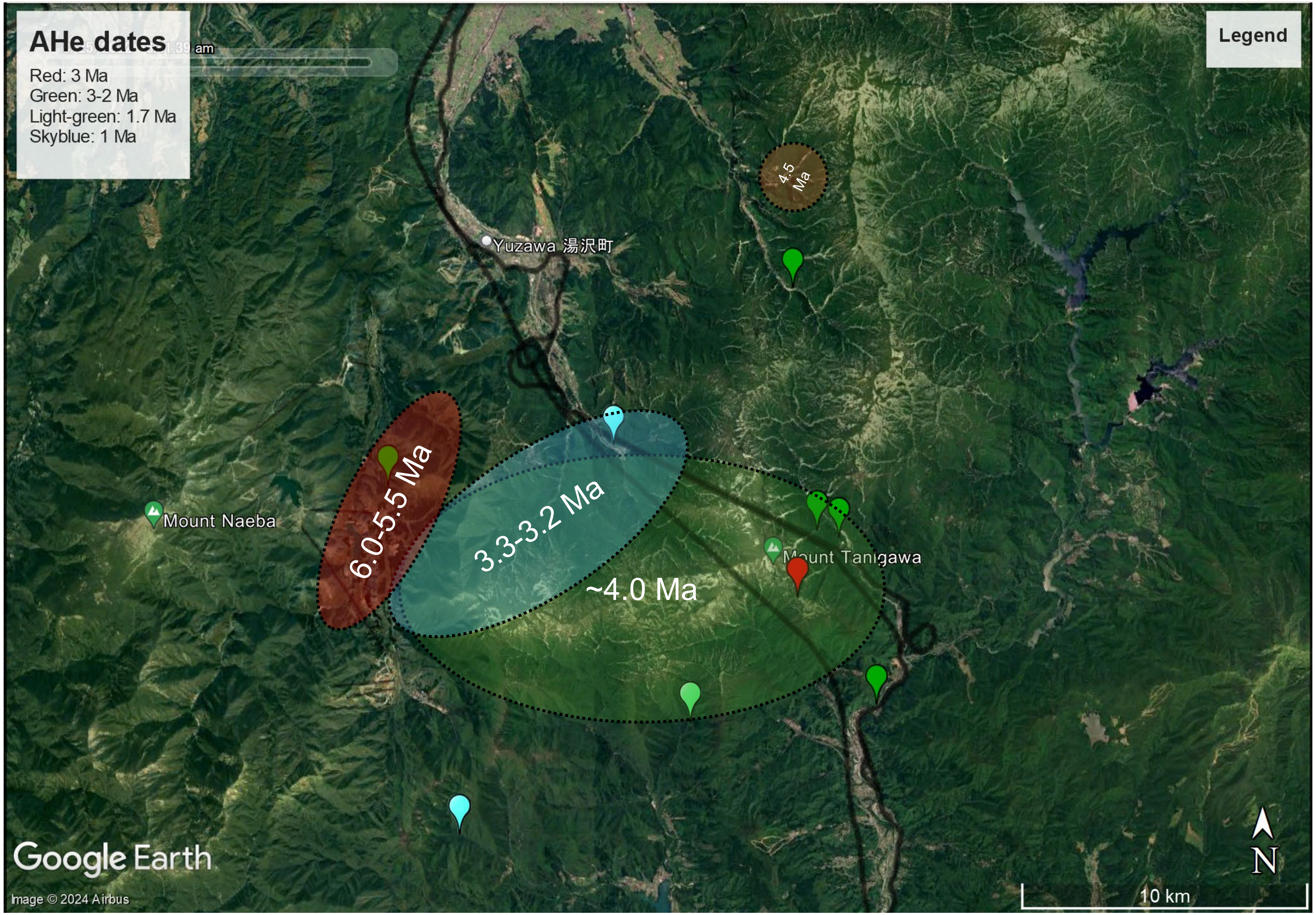
- ~4 Ma pluton distributes widely in the direction of E-W? (Batholith…?)
  Tanigawa body were formed by three intrusions.
- ~4.5 Ma pluton are also found in the northern part of Makihata body.
- The Tanigawa-dake young granites are too much complicated.

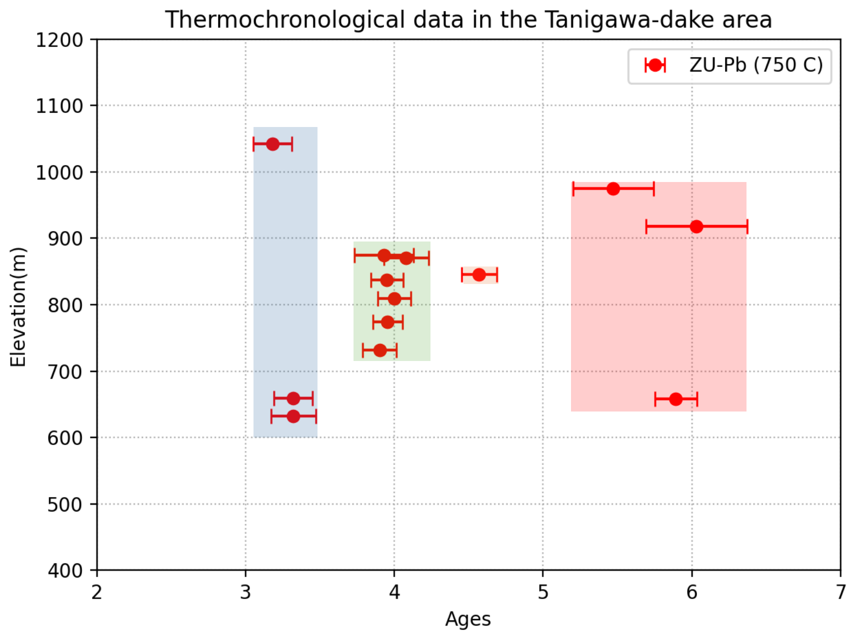


- AHe dates are significantly younger than ZU-Pb dates (Consistent with the relation of closure temp.)
- Rapid cooled samples (e.g.,5.5 Ma and 4 Ma) can be potentially reflected by newer intrusions than each sample with the spatial distribution map of ZU-Pb ages. (Geotherm at AHe and ZHe dates are not equilibrium?)

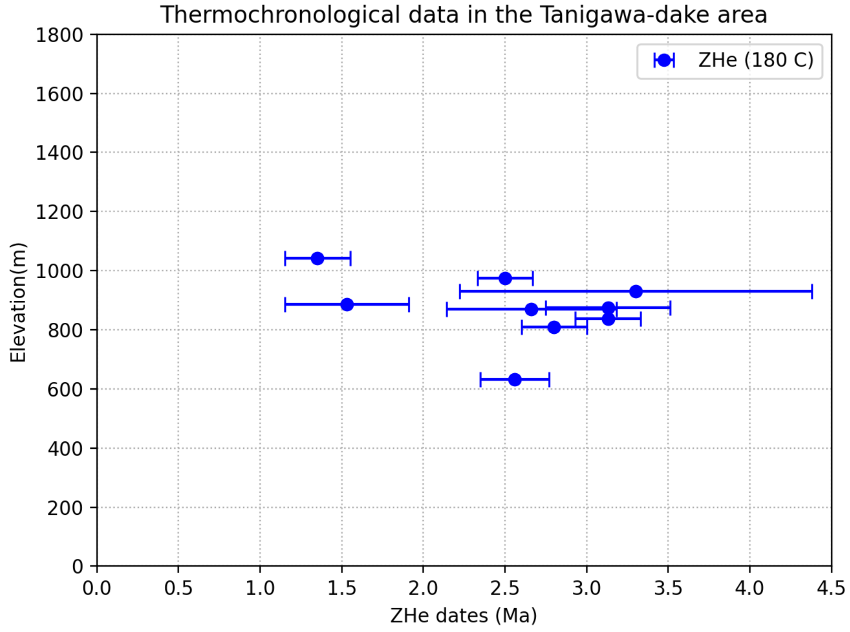


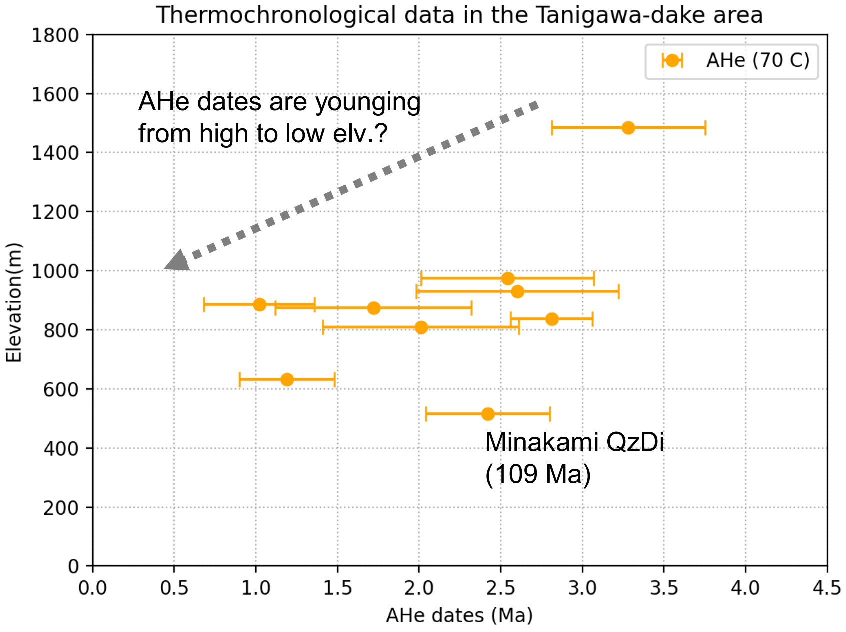
Thermochronological data in the Tanigawa-dake area
ZU-Pb (750 C)
ZHe (180 C)
AHe (70 C)
Ages (Ma)
1
2
3
4
5
6
36.75
36.80
36.85
36.90
36.95
Latitude


AHe dates
Red: 3 Ma
Green: 3-2 Ma
Light-green: 1.7 Ma
Skyblue: 1 Ma
Legend
4.5 Ma
Yuzawa 湯沢町
6.0-5.5 Ma
3.3-3.2 Ma
~4.0 Ma
Mount Naeba
Mount Tanigawa
N
10 km
Google Earth
Image © 2024 Airbus

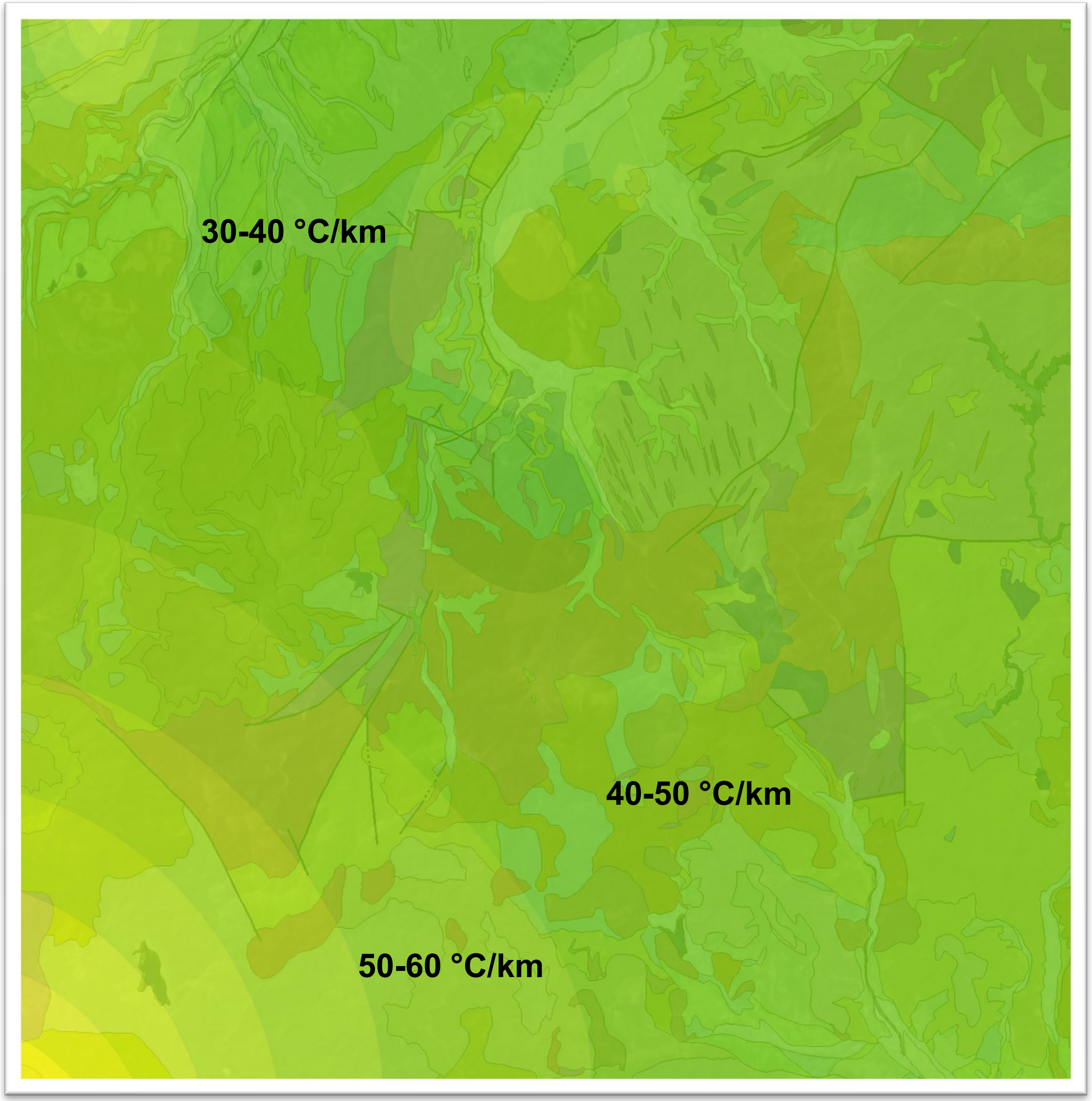


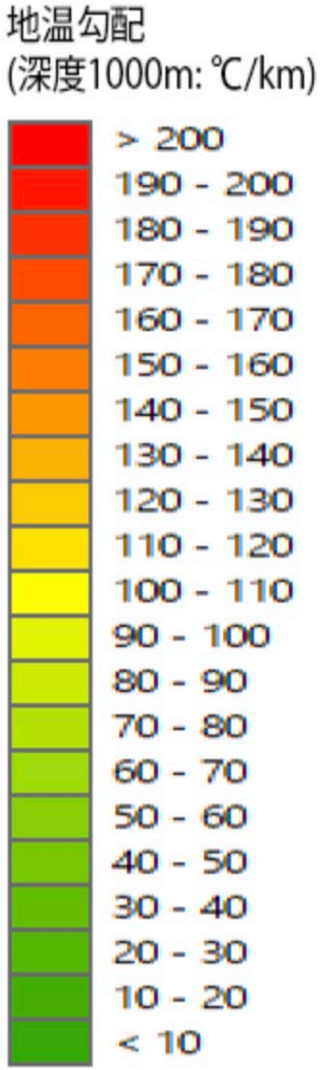
- Same intrusive bodies are exposed at low to high elevations.
  6.0-5.5 Ma: 670-980 m (delta h = 210 m)
  4 Ma: 720- 880 m (delta h = 160 m)
  3 Ma: 620-1040 m (delta h = 420 m)
- Even at high elevation, younger AHe and ZHe are found.





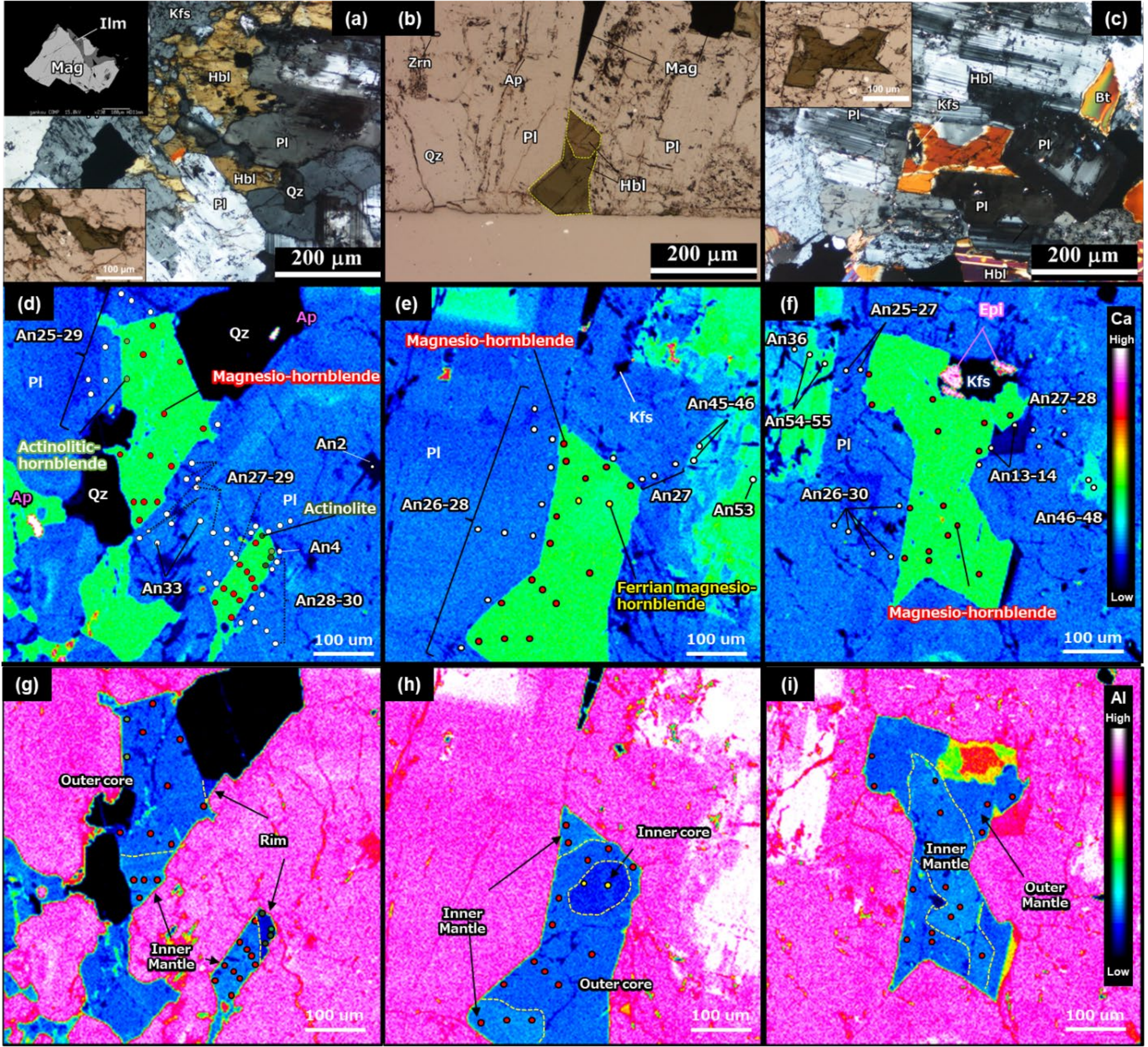
Current geothermal gradient in study area (Borehole)



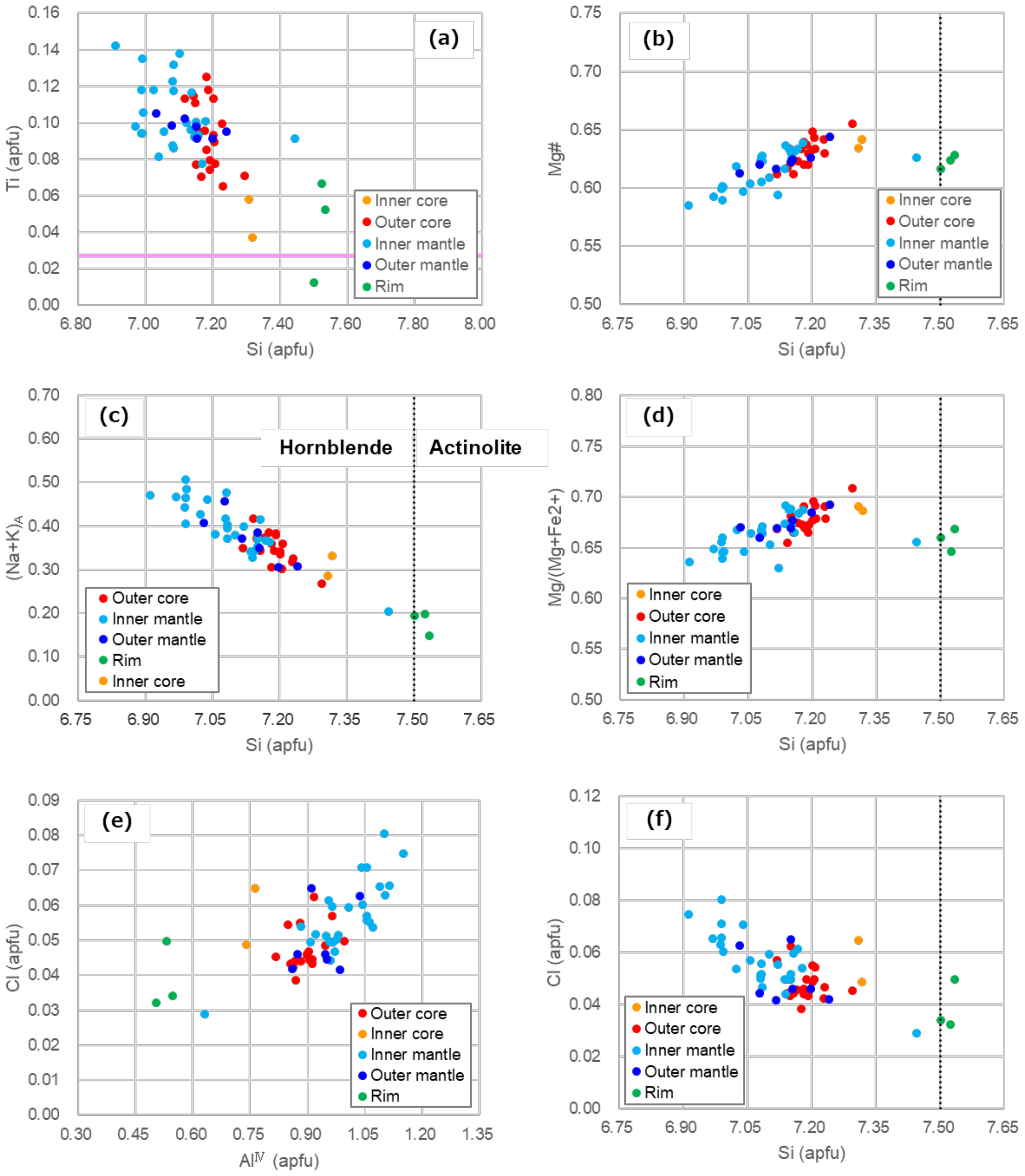


https://gbank.gsj.jp/geonavi/

Al-in-Hbl geobarometry



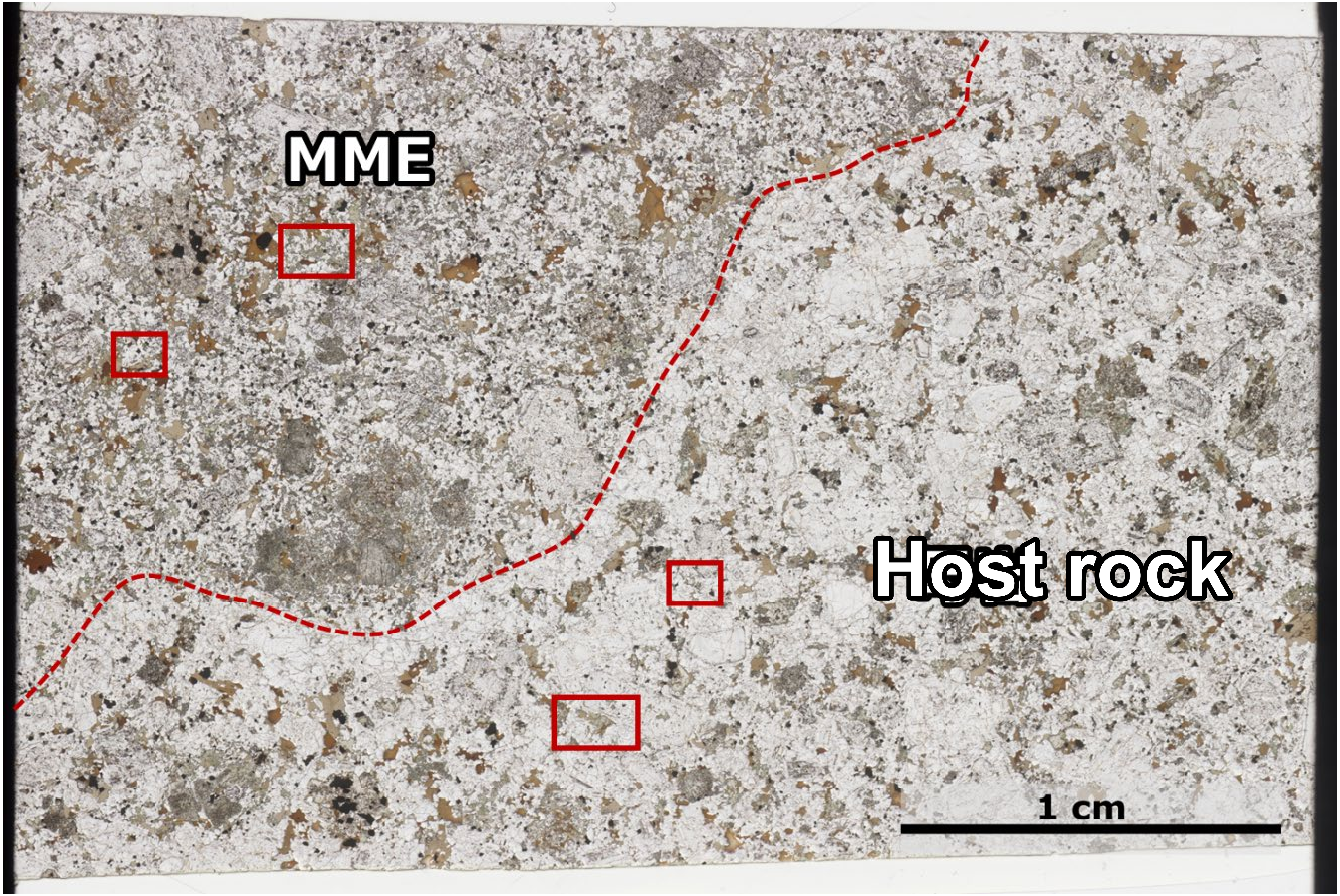
TNG22-11:
(a),(b),(c) Polarizing microscope images (open and cross) and BSE image,
(d), (e), (f) X-ray map of Ca,
(g), (h), (i) X-ray map of Al.
Circle points:
- ● : Magnesio-hornblende
- ● : Magnesio-ferri-hornblende
- ● : Actinolitic-hornblende
- ● : Actinolite
- ○ : Plagioclase

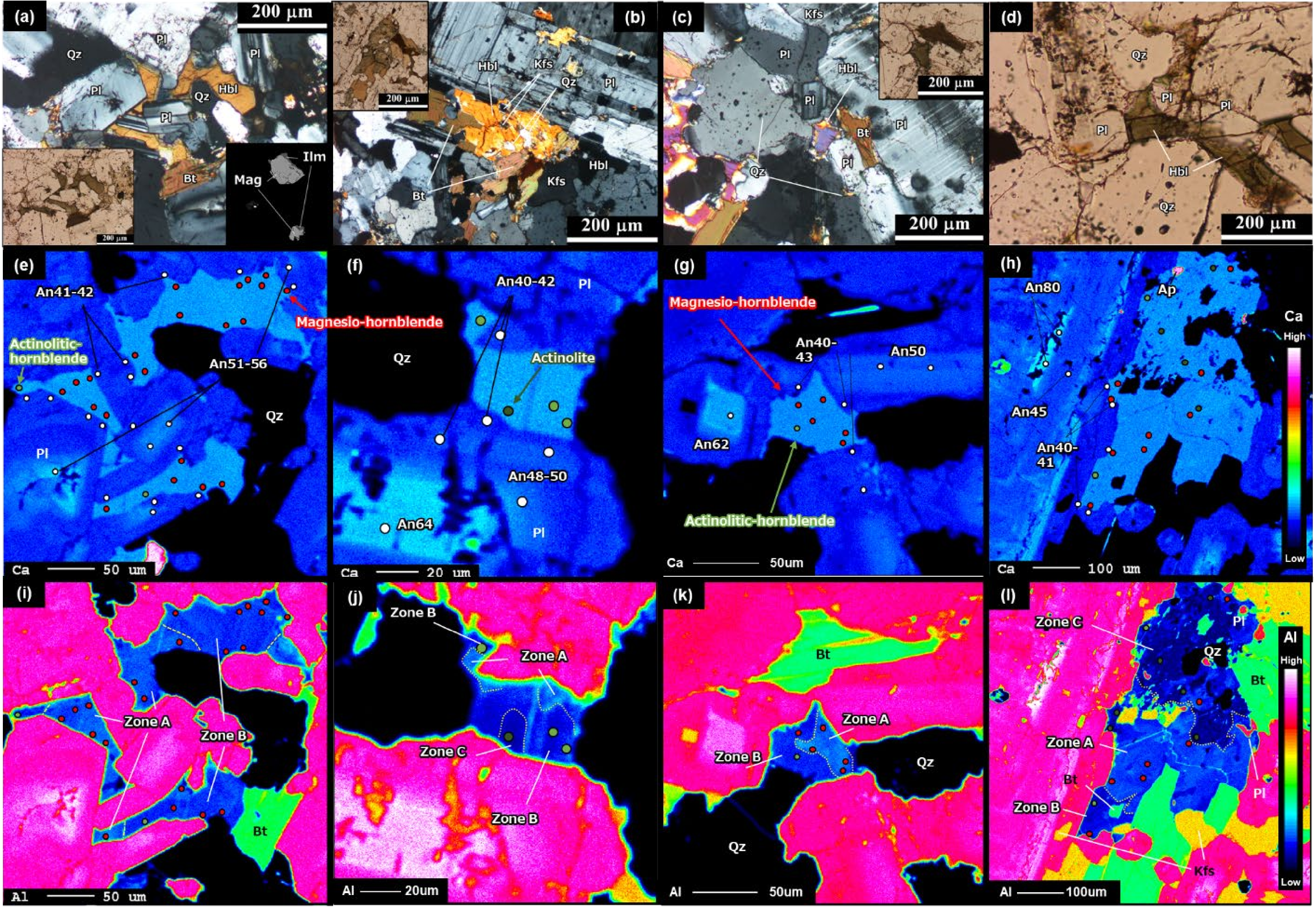


Chemical composition of TNG22-11 (apfu = atom per formula unit (O = 23)).

(a) Si vs Ti, (b) Si vs Mg# [Mg#=Mg/(Mg+Fe^{2+}+Fe^{3+})], (c) Si vs $(Na+K)_A$、(d) Si vs Mg/(Fe^{2+}+Mg), (e) Al^{IV} vs Cl, (f) Si vs Cl. Black broken line is a boundary in solid solution of hornblende. Pink line is a boundary of Ti (Ti = 0.027) to apply Al-in-Hbl geobarometry by Mutch et al., (2017).

TNG22-33
Thin section





TNG22-33 (Host rock):

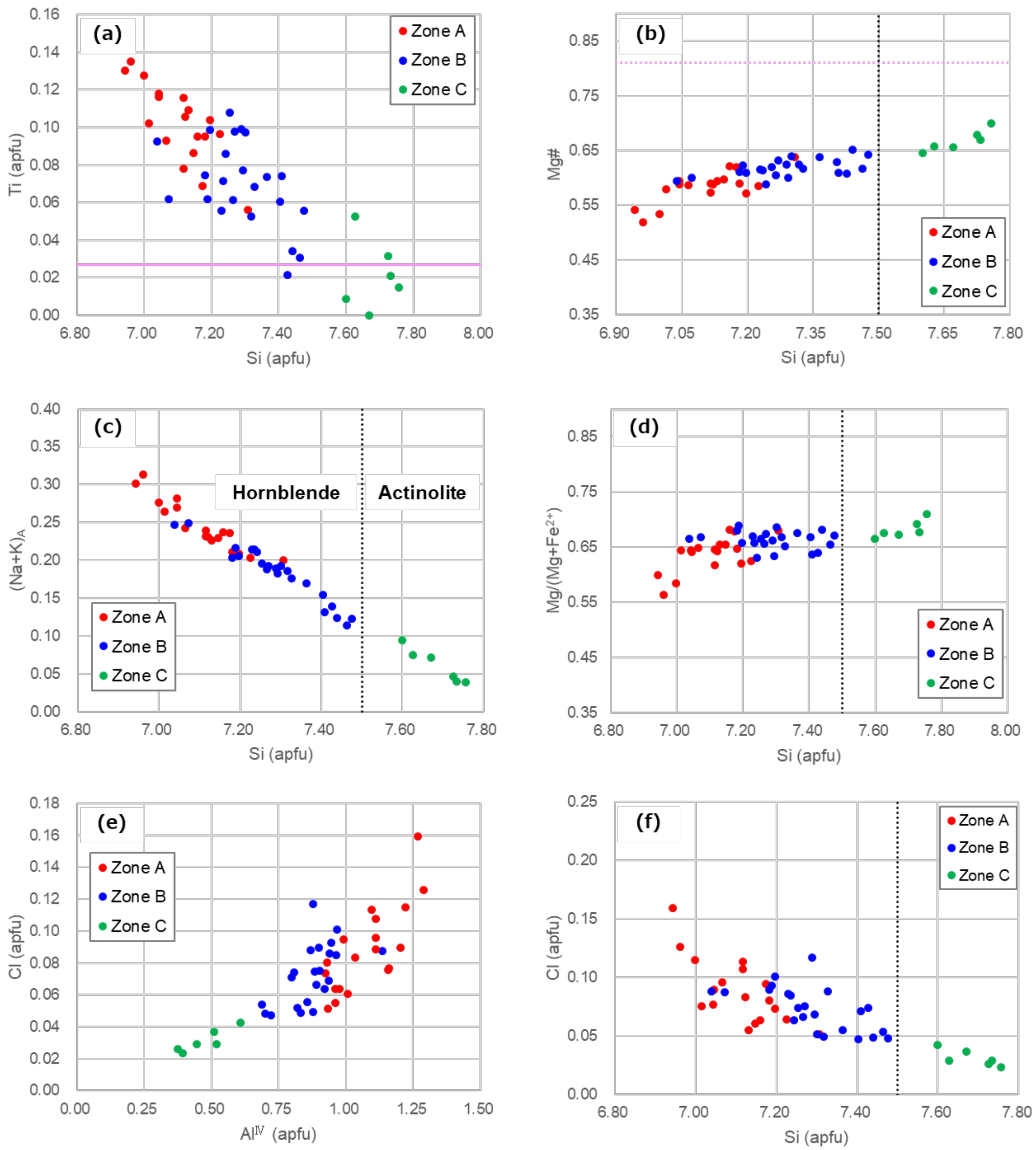
(a),(b),(c) Polarizing microscope images (open and cross) and BSE image

(d), (e), (f) X-ray map of Ca,

(g), (h), (i) X-ray map of Al.

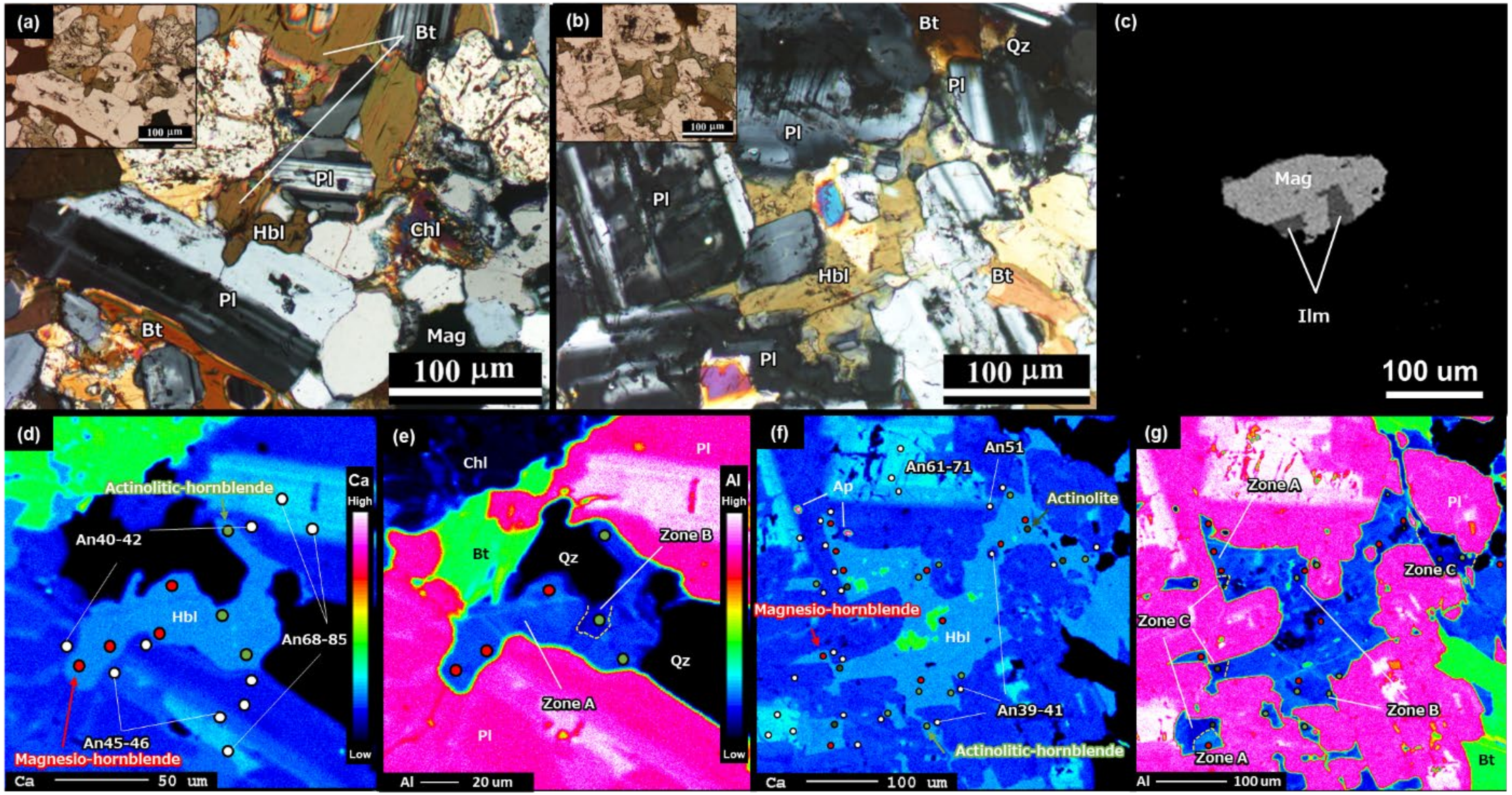
Circle points:

- ● : Magnesio-Hbl
- ● : Actinolitic-Hbl
- ● : Actinolite
- ○ : Plagioclase



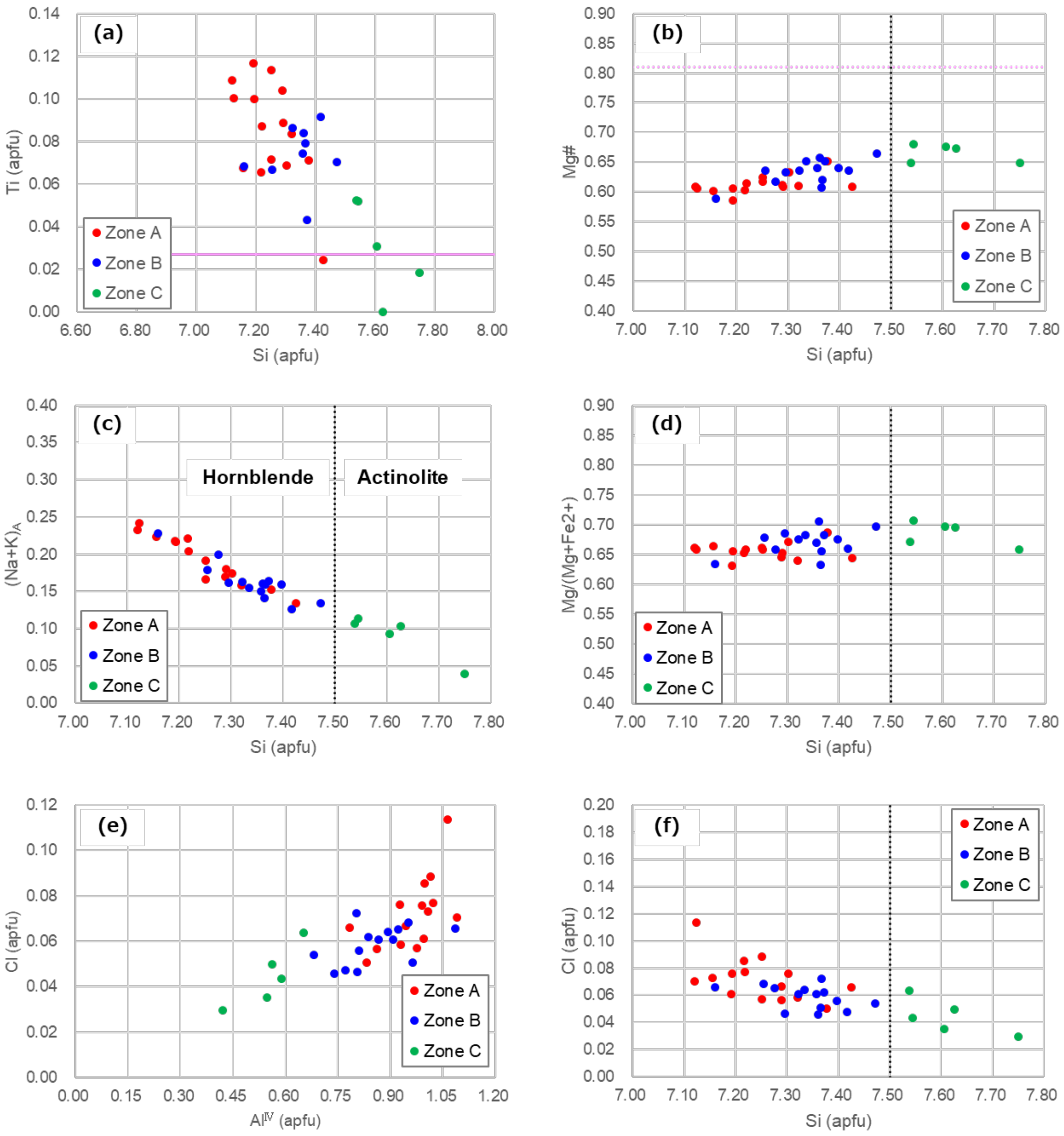
Chemical composition of TNG22-33 (Host rock) (apfu = atom per formula unit (O = 23)).

(a) Si vs Ti, (b) Si vs Mg# [Mg#=Mg/(Mg+Fe^{2+}+Fe^{3+})], (c) Si vs $(Na+K)_A$、(d) Si vs Mg/(Fe^{2+}+Mg), (e) Al^{IV} vs Cl, (f) Si vs Cl. Black broken line is a boundary in solid solution of hornblende. Pink line and pink broken line are boundary of Ti (Ti = 0.027) and boundary of Mg# (Mg# =0.81) to apply Al-in-Hbl geobarometry by Mutch et al., (2017), respectively.



TNG22-33 (MME):

(a),(b) Polarizing microscope images (open and cross),
(c) BSE image,
(d), (e), (f) X-ray map of Ca,
(g), (h), (i) X-ray map of Al.
Circle points:
● : Magnesio-hornblende
● : Actinolitic-hornblende
● : Actinolite
○ : Plagioclase

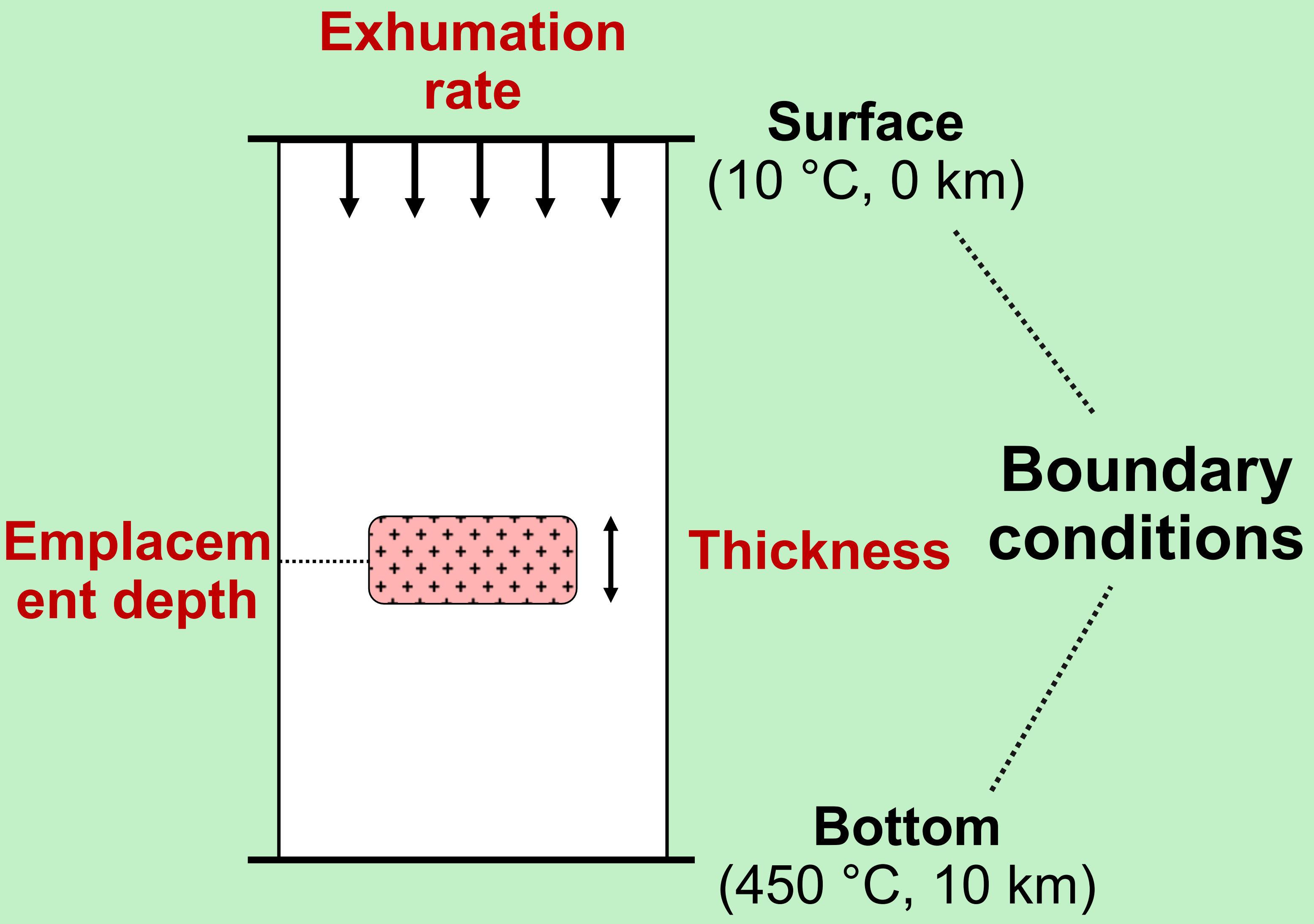


Chemical composition of TNG22-33 (MME) (apfu = atom per formula unit (O = 23)).

(a) Si vs Ti, (b) Si vs Mg# [Mg#=Mg/(Mg+Fe^{2+}+Fe^{3+})], (c) Si vs $(Na+K)_A$、(d) Si vs Mg/(Fe^{2+}+Mg), (e) Al^{IV} vs Cl, (f) Si vs Cl. Black broken line is a boundary in solid solution of hornblende. Pink line and pink broken line are boundary of Ti (Ti = 0.027) and boundary of Mg# (Mg# =0.81) to apply Al-in-Hbl geobarometry by Mutch et al., (2017), respectively.

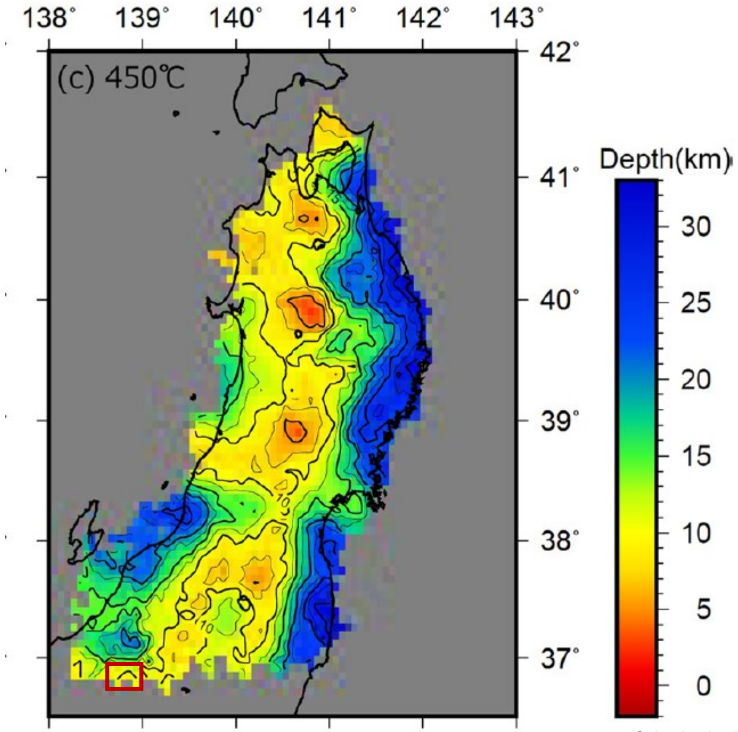
1D numerical simulation

Input parameters to disturb geotherm & Boundary conditions:



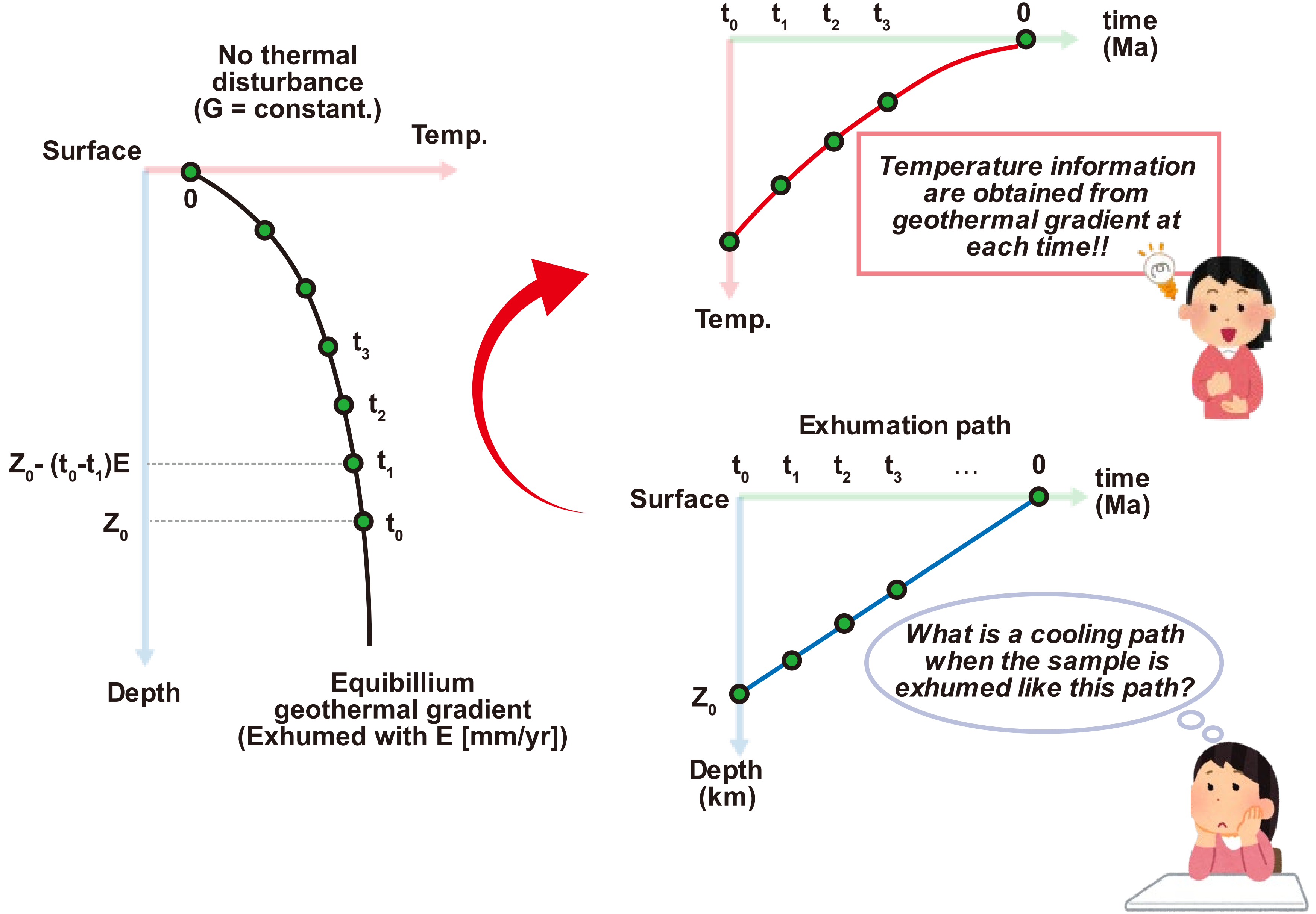
Matsumoto et al. (2022)

Boundary condition:

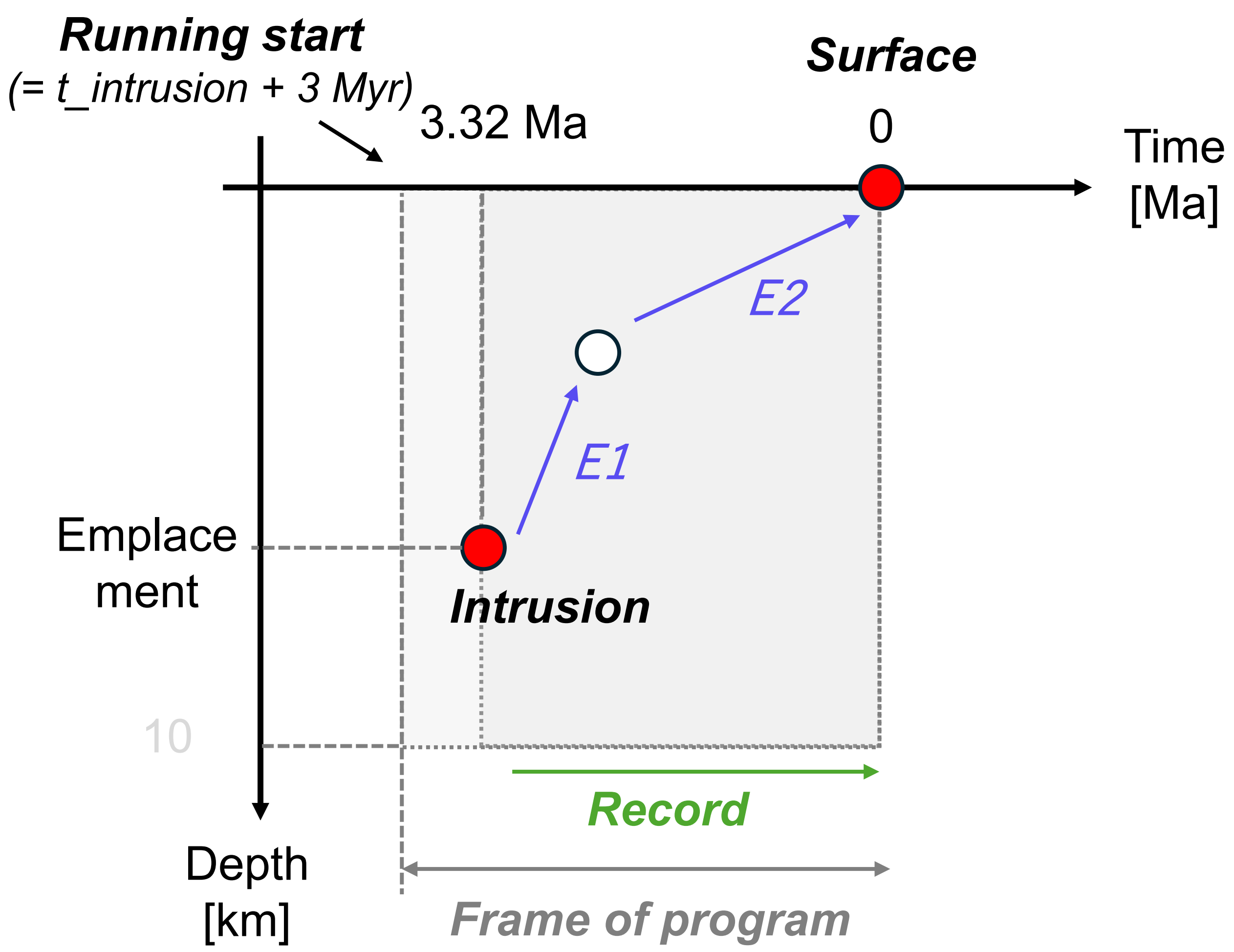


Matsumoto et al. (2022)

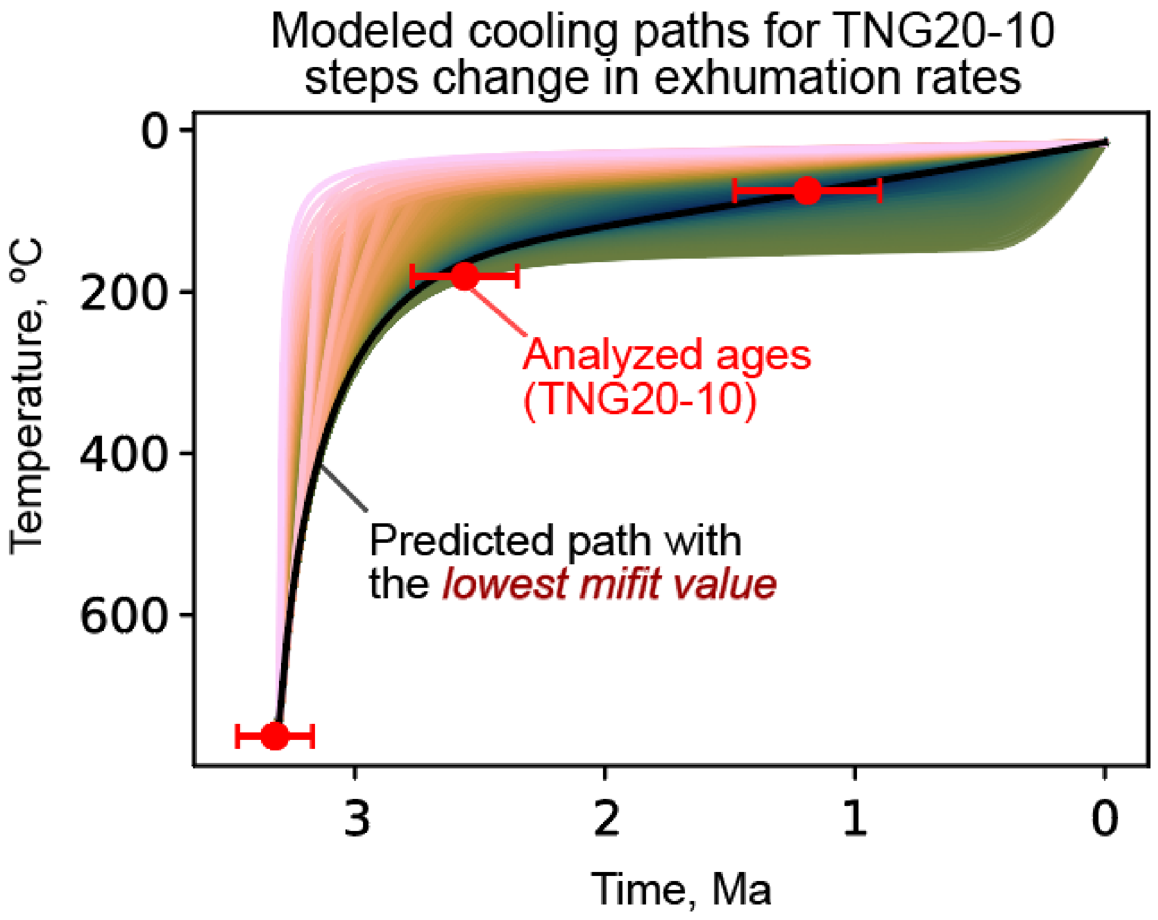
Conceptual diagram - How do we obtain cooling path from G and exhumation path?

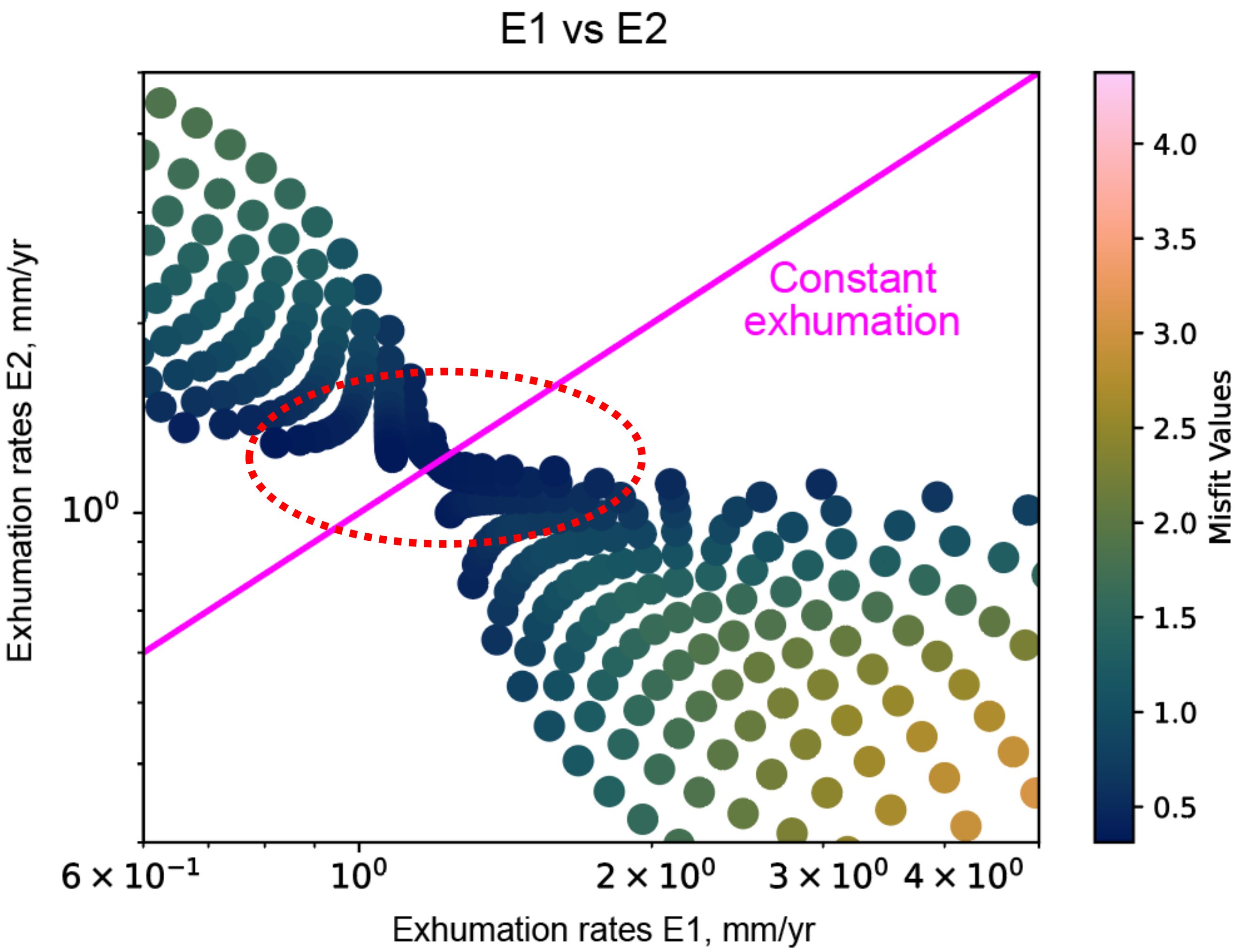


Step changes in exhumation rates test



In the case of Depth = 4.0 km, Thickness = 4.5 km





- Lowest misfit value = 0.31
  c.f., In constant exhumation rate test,
  lowest misfit value = 0.36.