Subduction of a rifted passive continental margin: the Pohorje case of Eastern Alps - constraints from geochronology and geochemistry

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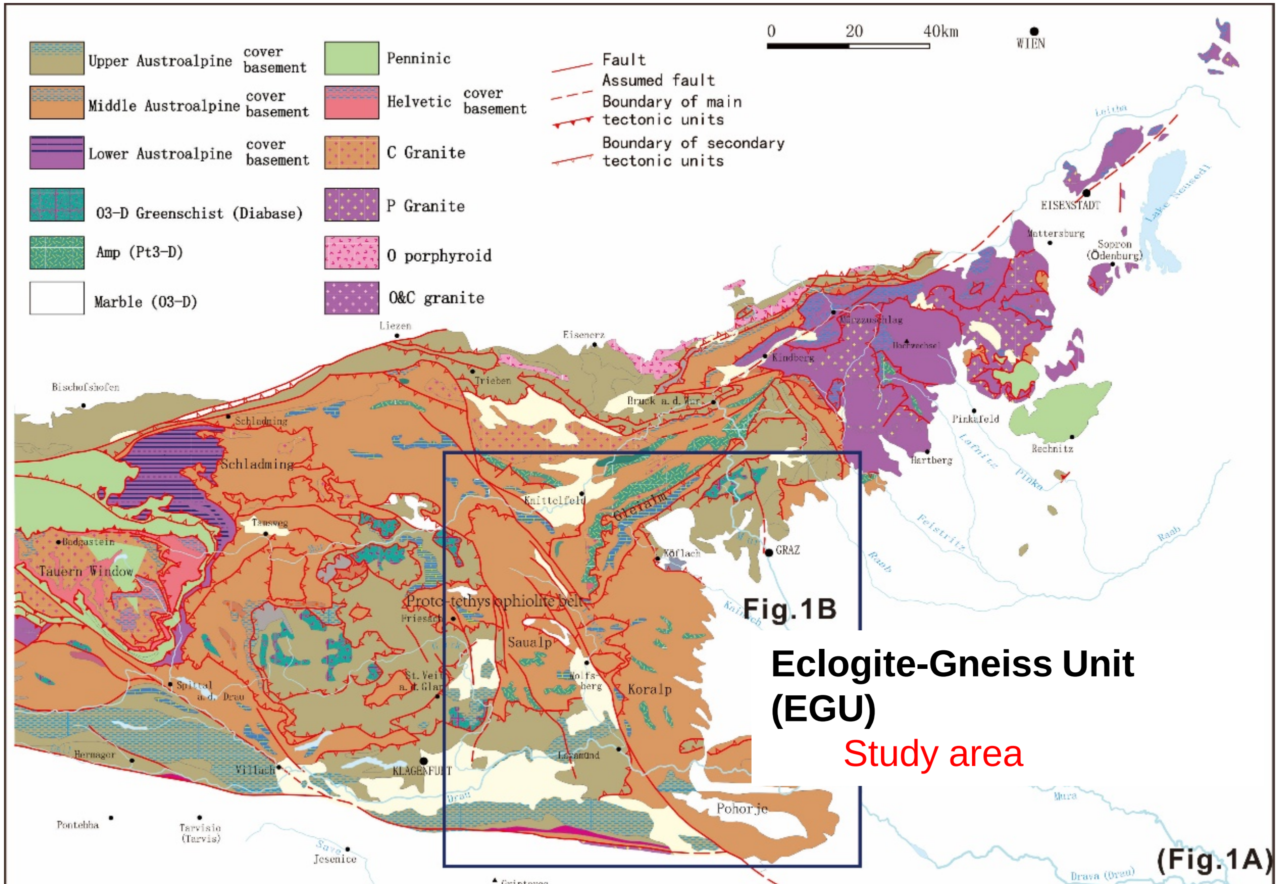
Outline

- Introduction
- The geological background and problems
- Sample locations
- Research methods and results
- Discussion and Conclusions

Introduction

Eastern Alps: the result of the convergence of two independent Alpidic collisional orogenic belts



constituted of :

Austroalpine nappe stack

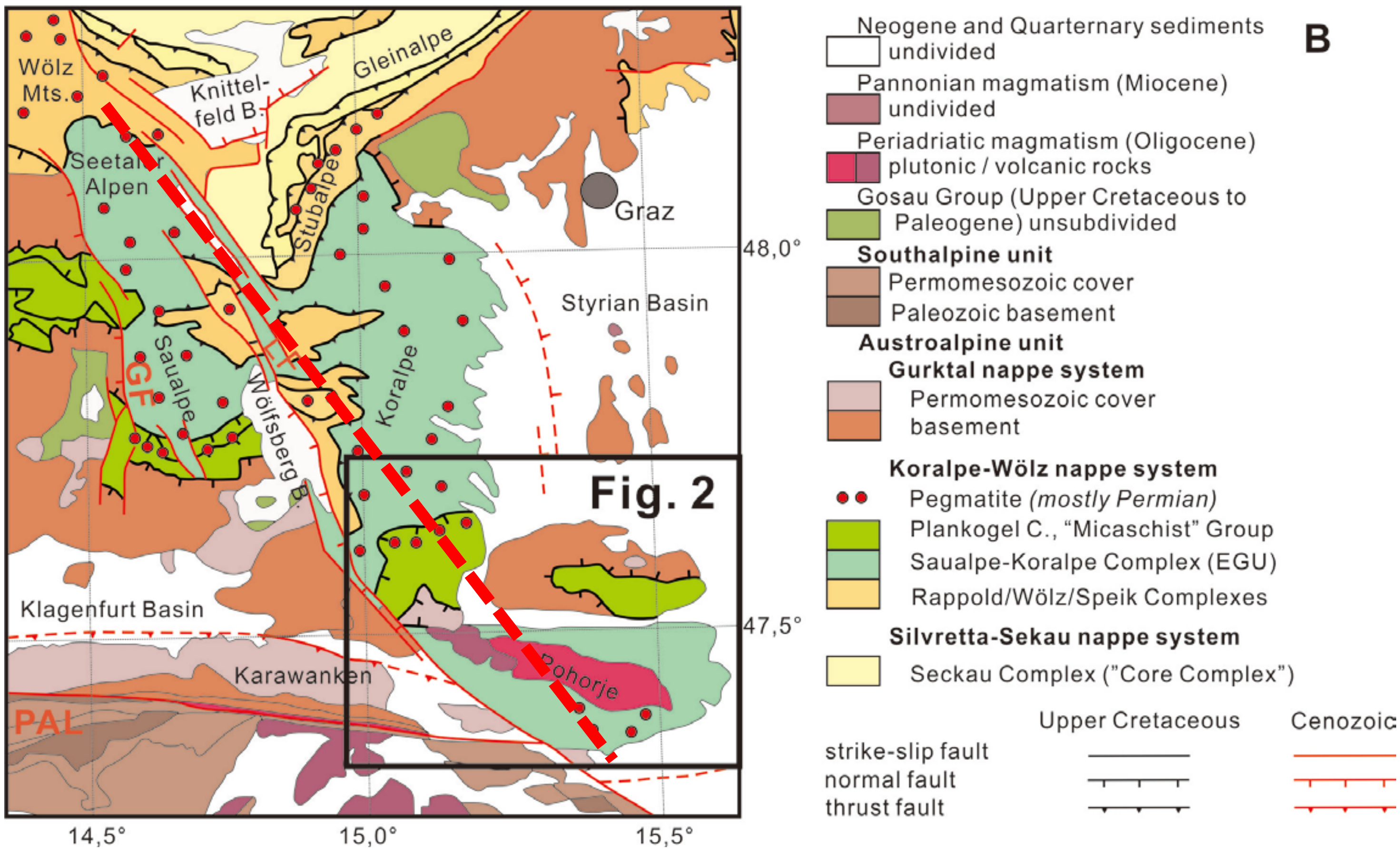
(can be divided into a strongly imbricated **Lower Austroalpine nappe complex** with several internal nappes, a thick **Middle Austroalpine nappe complex** that is mainly composed of polymetamorphic basement rocks, and the **Upper Austroalpine nappe complex**)

Two windows

Tauern window and **Rechnitz window**, enable a look onto Penninic and Helvetic rocks flysch sediments underlies the thrust plane at the base of the Austroalpine nappe stack.

The geological background and problems

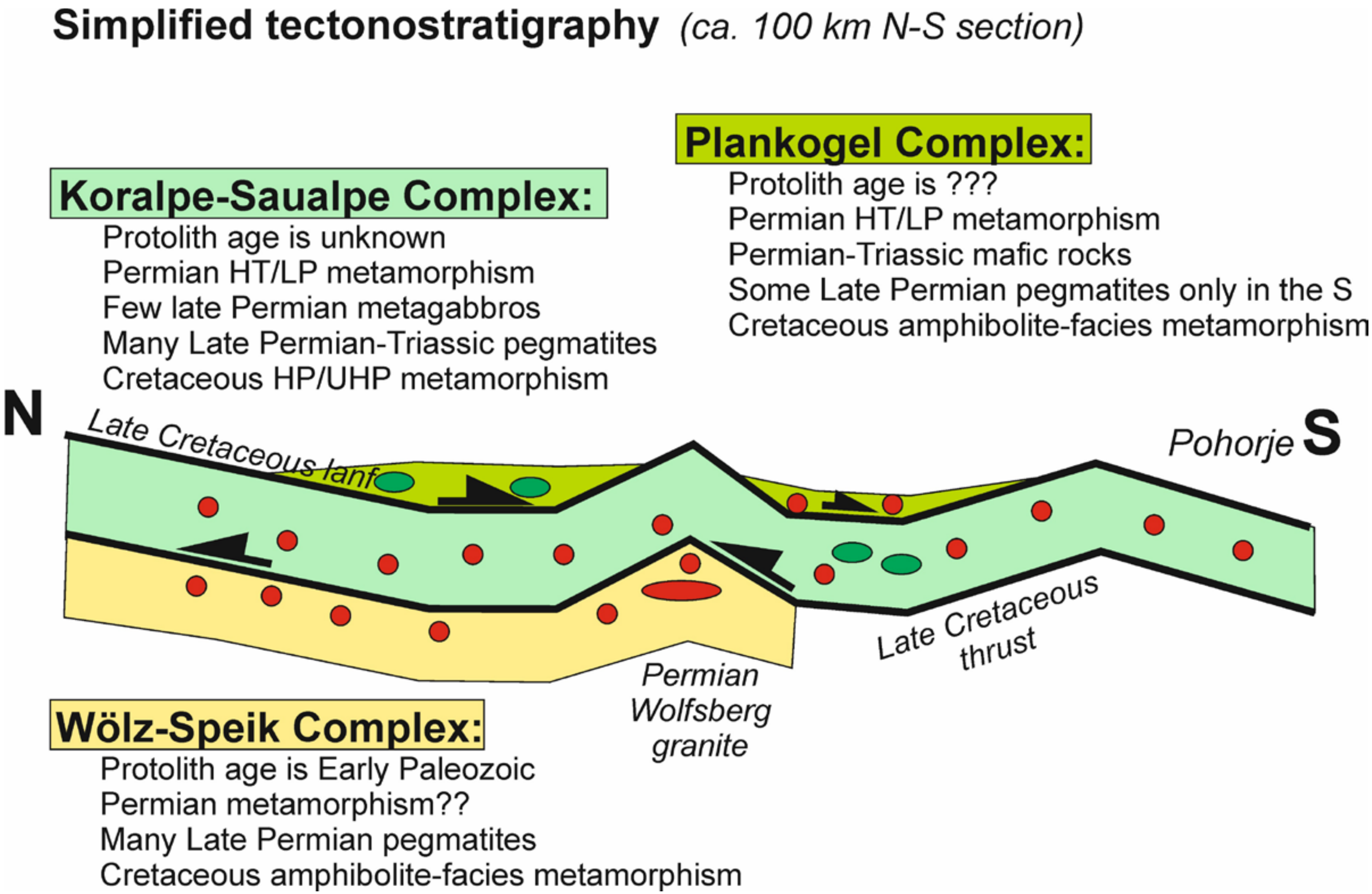
EGU comprises a succession of metamorphic rocks with continental affinity.



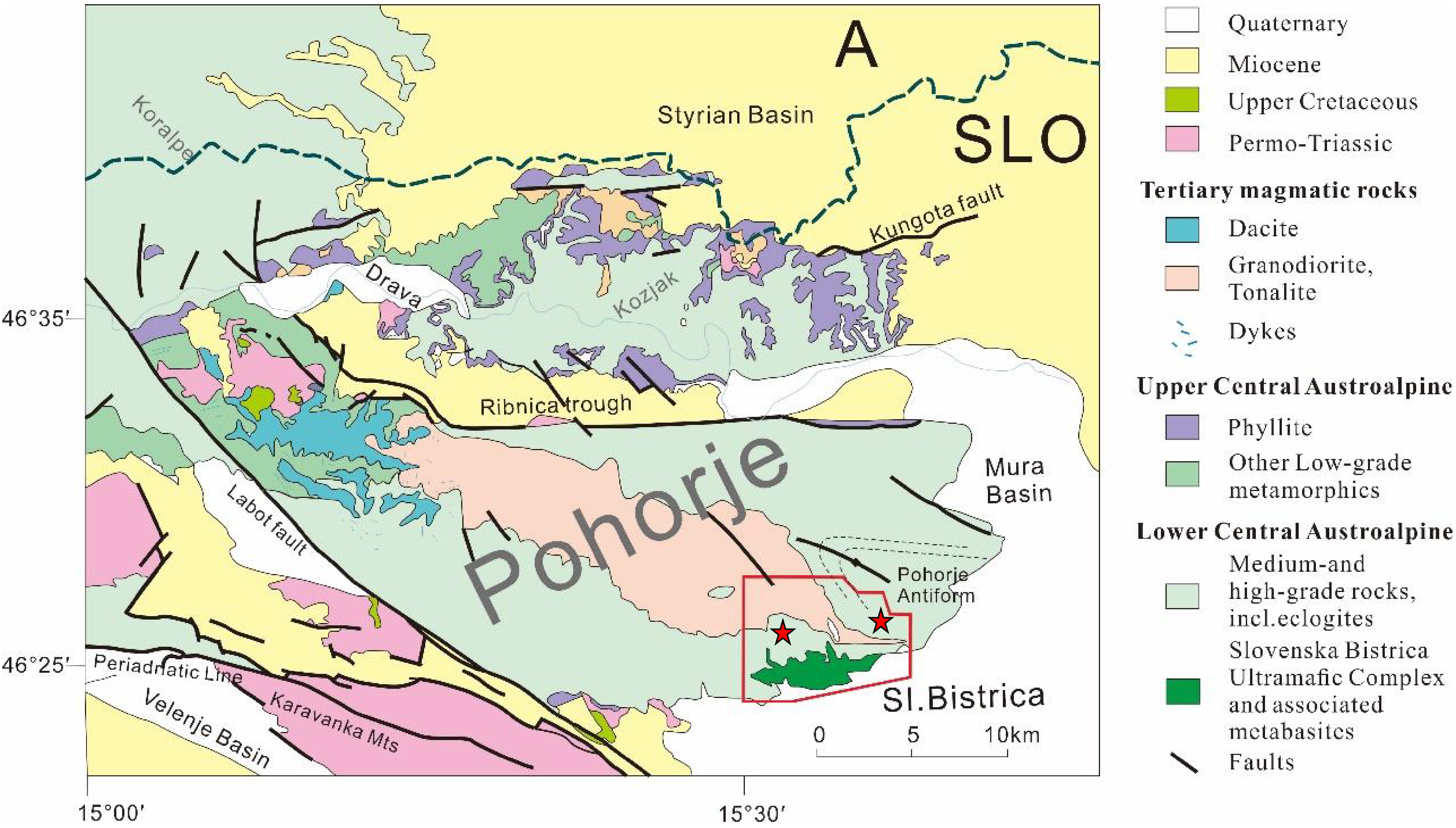
modified after Miller et al. 2005

includes various paragneisses, rare marble and quartzites and intercalated eclogites, rare metagabbro and pegmatites

The geological background and problems

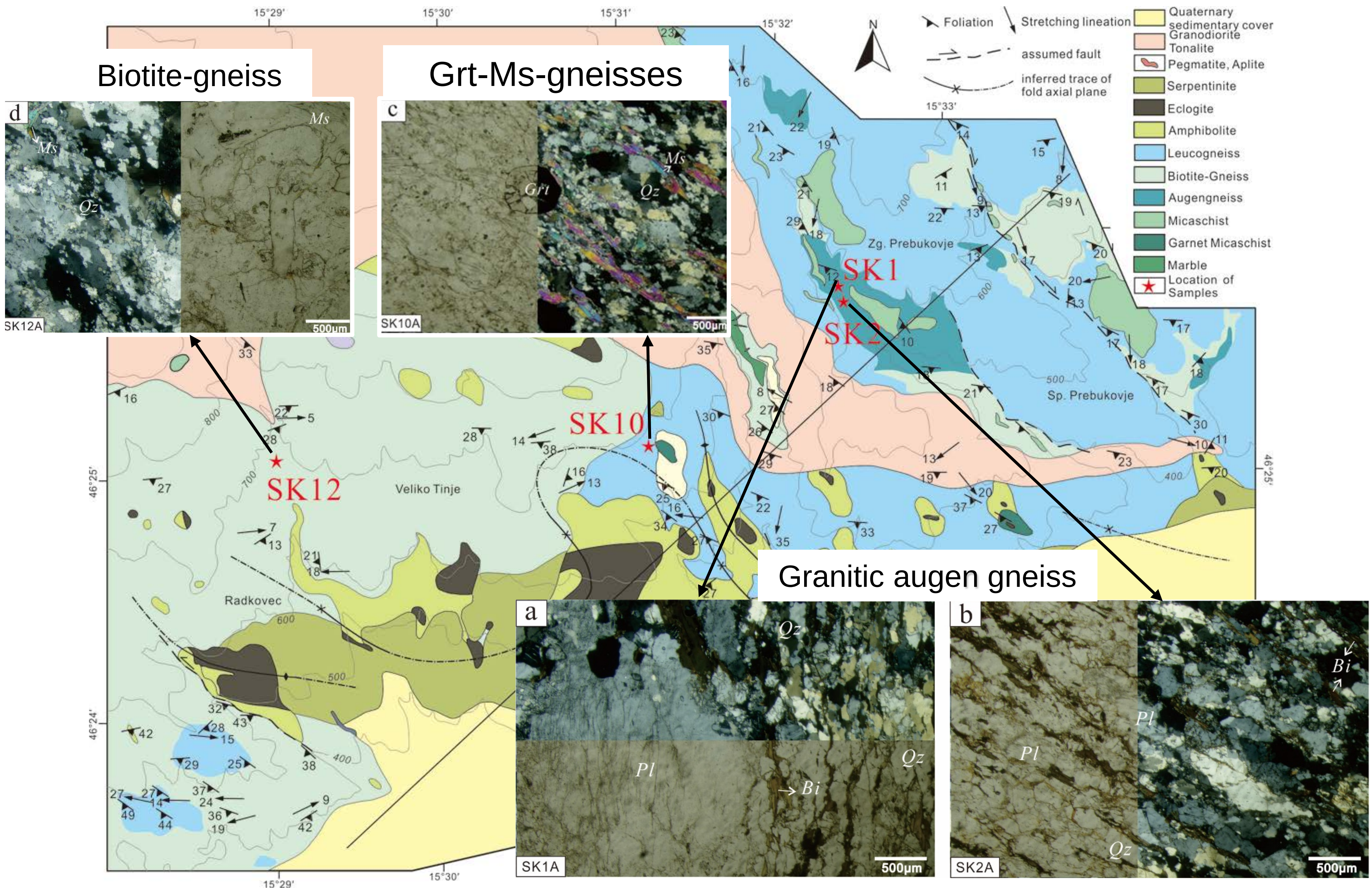


Sample location



modified from Mioč and Žnidarčič 1977

Sample location

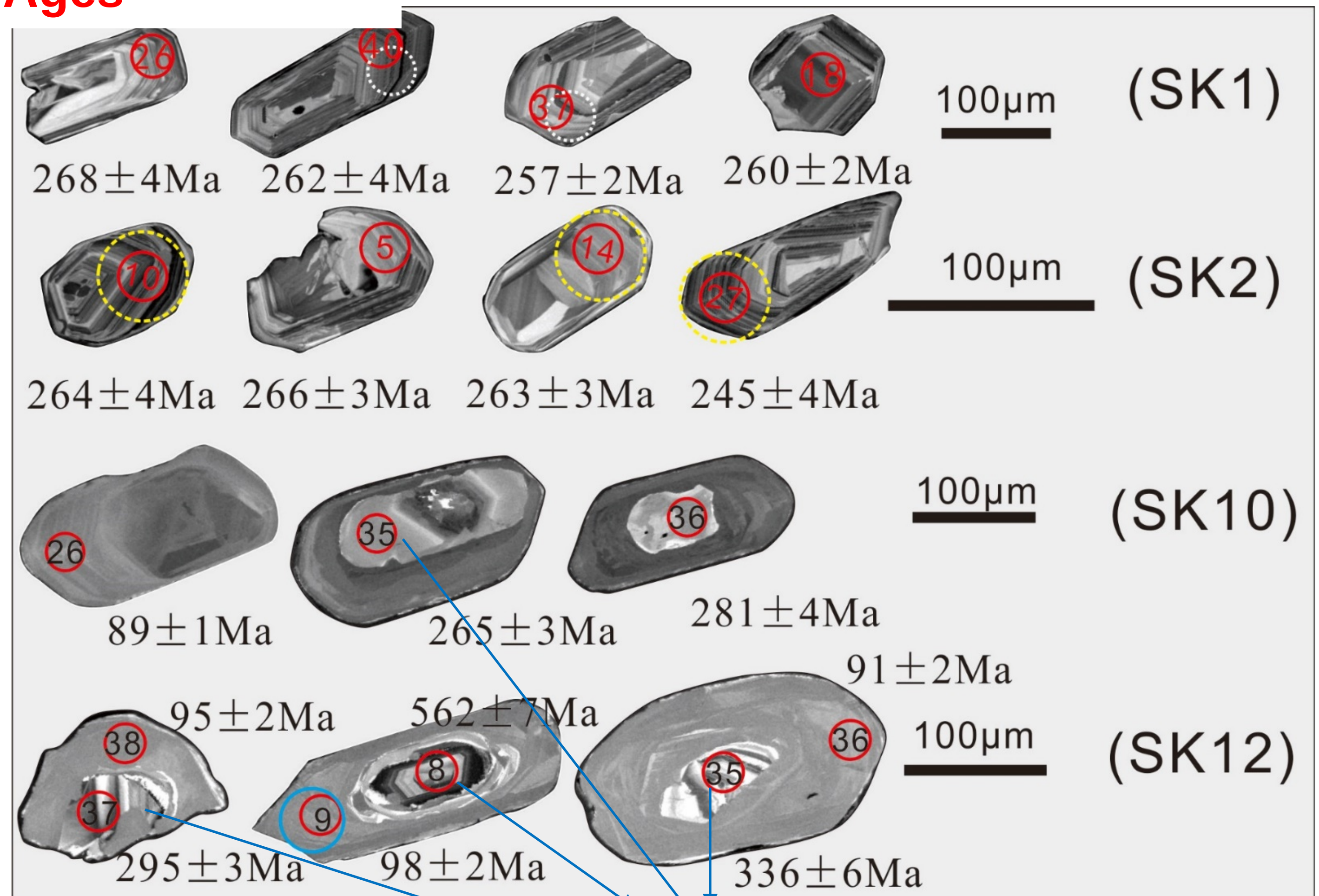


Map modified after Kirst et al. 2010

Research methods and results

Zircon U-Pb Ages

Aim: To determine the age of magmatic or metamorphic events



subhedral-euhedral

oscillatory zoning

high Th/U ratios of (0.12–1.30) >0.1

Magmatic age

rounded

Slightly oscillatory zoning

Low Th/U ratios (0.005–0.009) <0.01

Metamorphic age

inherited cores in which exhibit more clearly oscillatory zoning

Representative CL images of zircon crystals used for LA-ICP-MS dating from the Pohorje Mt.

Research methods and results

Why is difference in zircon between augengneiss and leucogneisses (beside their different locations)?

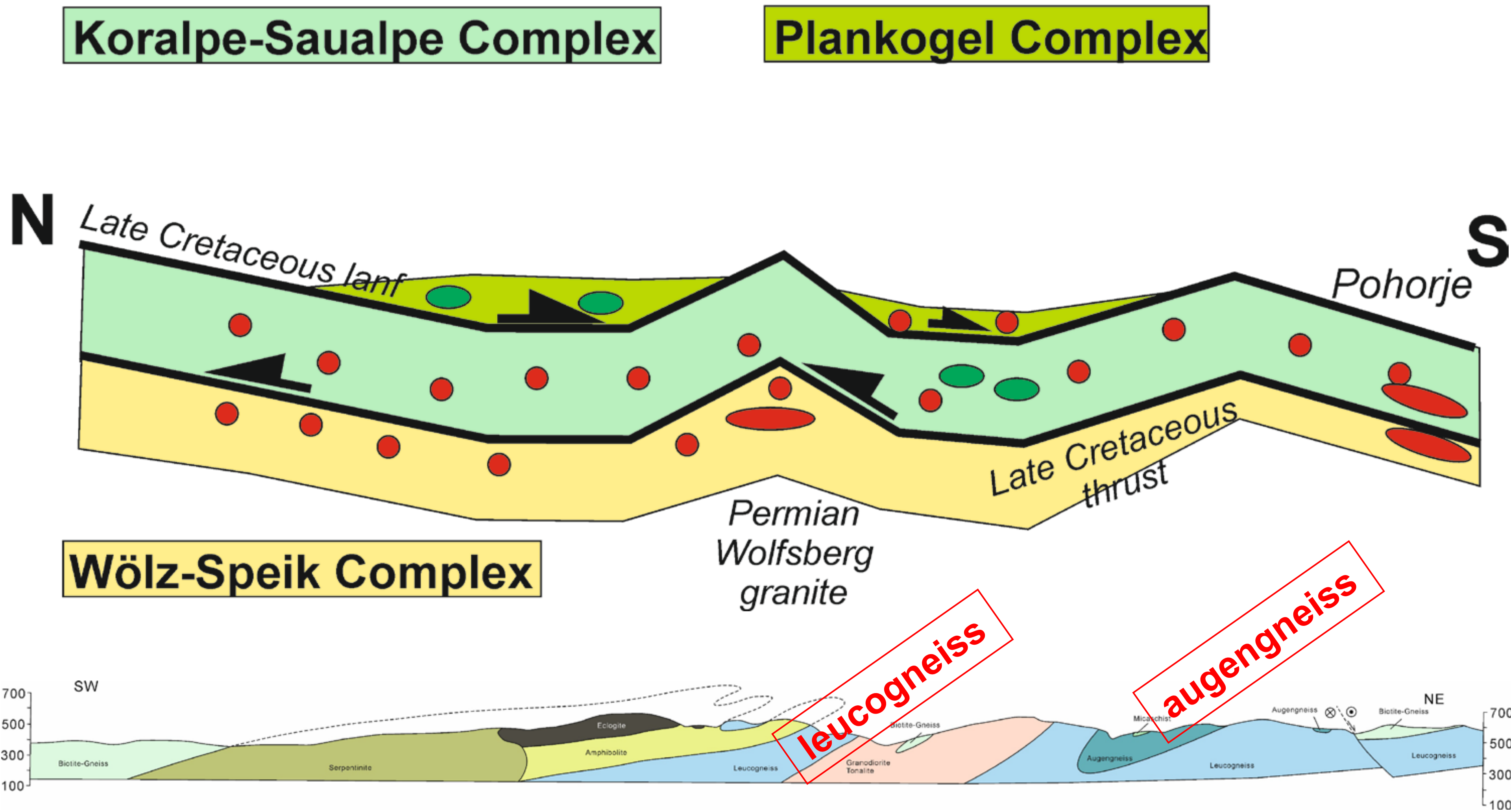
Augengneiss are hosted within amphibolite facies metamorphic rocks with no preserved fabrics of HP/UHP metamorphism (e.g., no retrogressed eclogites); metamorphic temperatures remained **< ca. 650 °C**.

Leucogneisses are hosted within an UHP environment (diamond-bearing country rocks: ≥3.5 GPa and **800–850 °C**, Janák et al., 2015, Journal of Metamorphc Geology)

Likely solution: **Two separate tectonic units with different metamorphic history?**

Research methods and results

Simplified tectonostratigraphy *(ca. 100 km N-S section)*



Section 2 of Kurst et al., 2010

Research methods and results

Zircon Hf isotope data

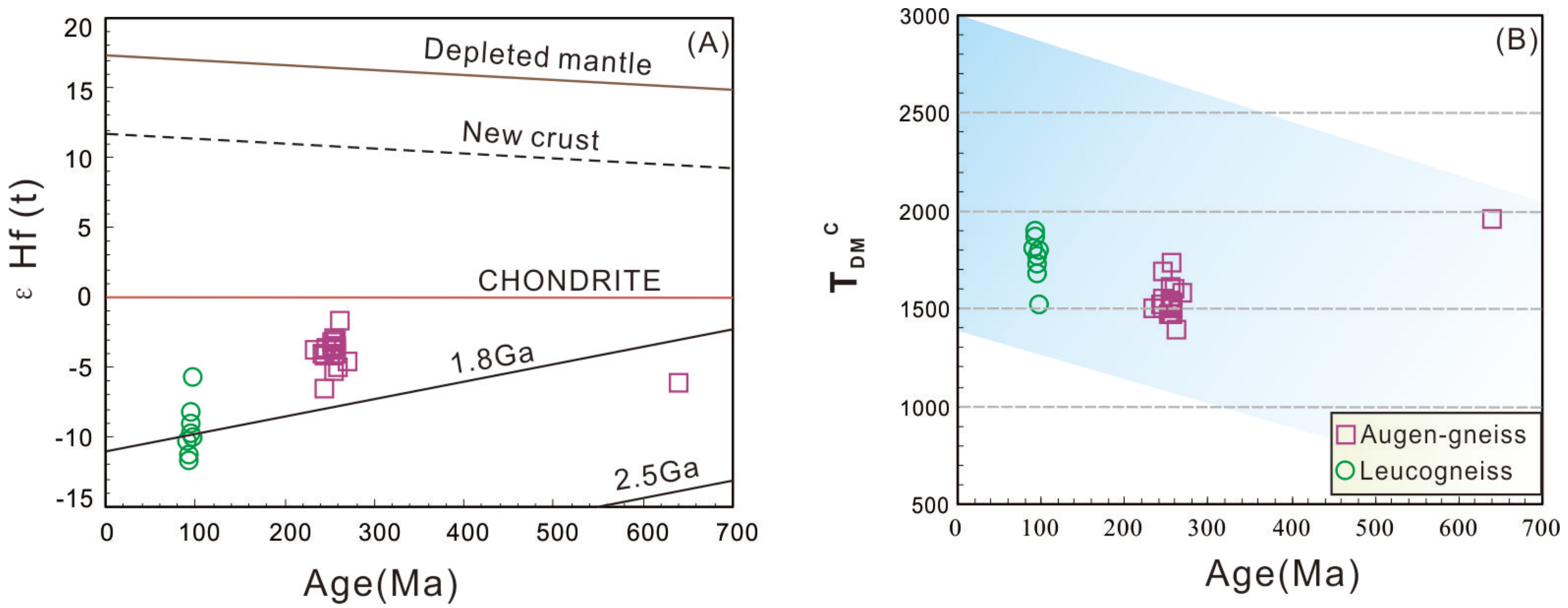
To retrospect and discuss magmatic origin

$^{176}Hf/^{177}Hf(t)$ values on magmatic zircon grains range between 0.282703 and 0.282868 (t = 255 Ma)

εHf(t) values between -6.4 and -1.7 and crustal model ages (T_{DM}^{C}) of 1392 to 1617 Ma

$^{176}Hf/^{177}Hf$ values on zircons from the leucogneisses of 0.282385–0.282562(t = 90 Ma)

εHf(t) values of -13.7 to -7.9 and yield Hf crustal model ages (T_{DM}^{C}) of 969–1195 Ma

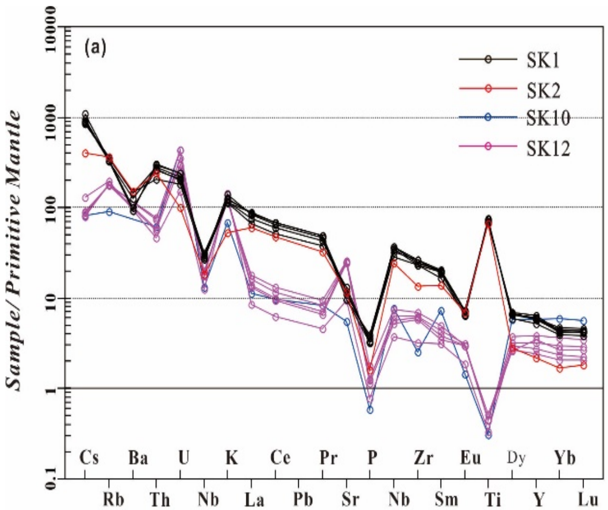


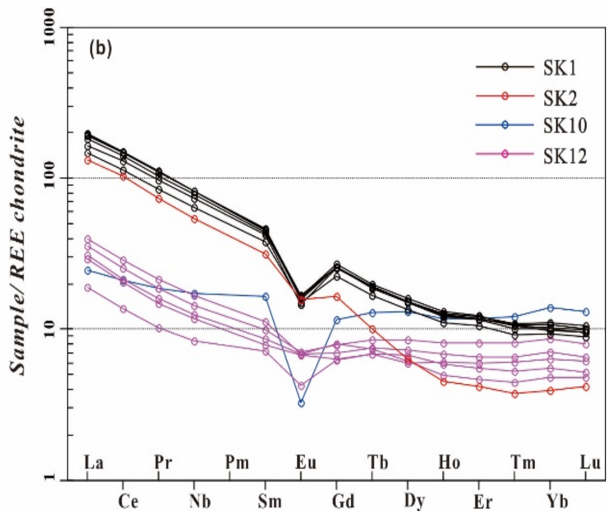
These data suggesting a predominantly Proterozoic crustal source.

Research methods and results

Geochemistry data

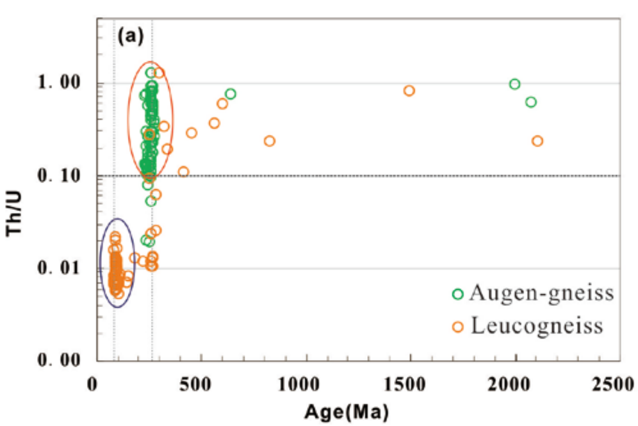
To constrain the origin of gneisses

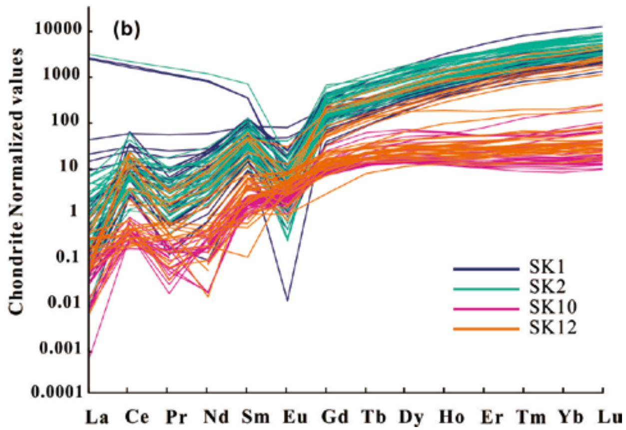




- Enrichment in LILEs; e.g., Rb, Sr, and K
- Depletion in HFSE, negative anomalies for P, Nb, Ba
- the paragneiss display lower normalized light REE
- The REE all characterized by a fractionation between light and heavy REEs
- have small negative Eu anomalies(probably resulting from plagioclase fractional)

the chondrite-normalized REE in leucogneisses obviously lower than it they are in augen orthogneiss





Chondrite-normalized REE patterns of zircon grains reveal that they are strongly depleted in light REEs relative to heavy REEs, and that they exhibit pronounced positive Ce, Sm and negative Eu anomalies Th/U ratio allow distinction of magmatic and metamorphic zircons

Research methods and results

Augengneiss samples

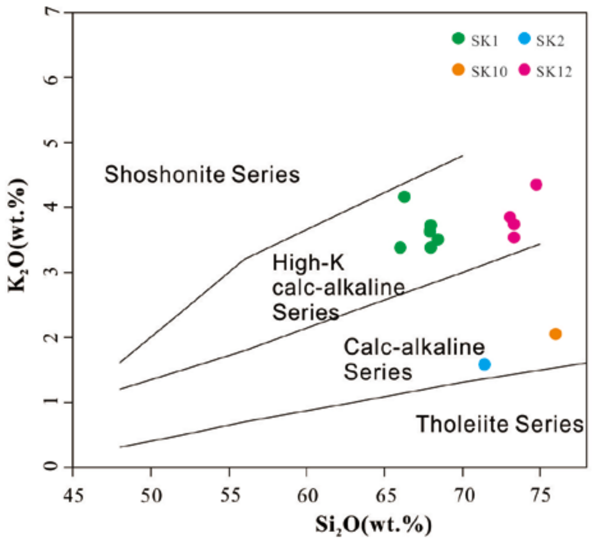
Na_2O/K_2O ratios less than 1

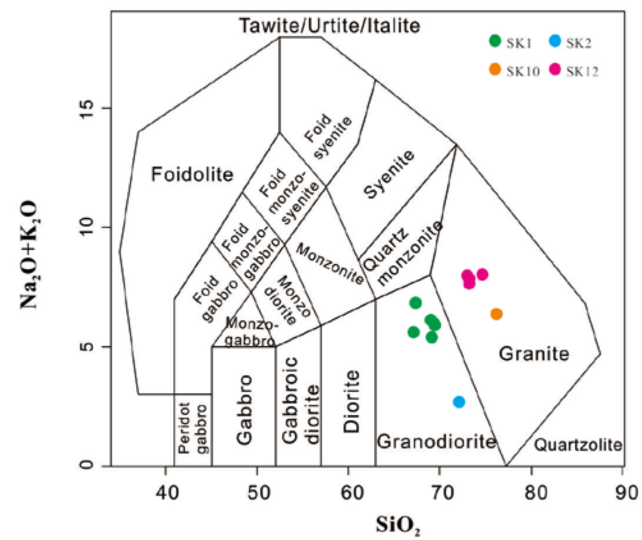
MnO (4.60–6.14 wt.%)

calc-alkaline

granodiorite

metaluminous





Leucogneiss samples

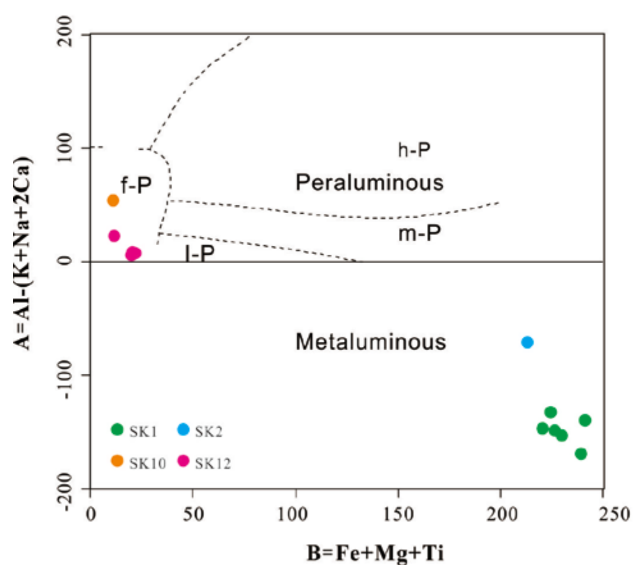
high Na_2O/K_2O ratio

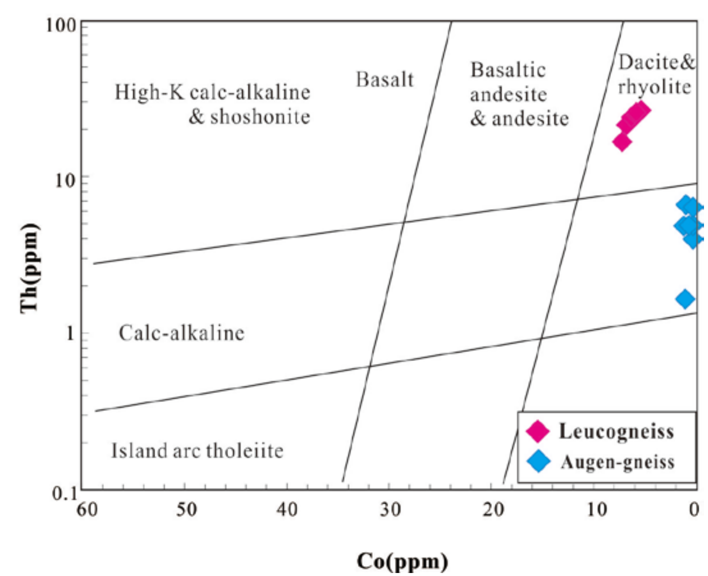
MnO (0.05–0.10 wt.%)

high-K calc-alkaline

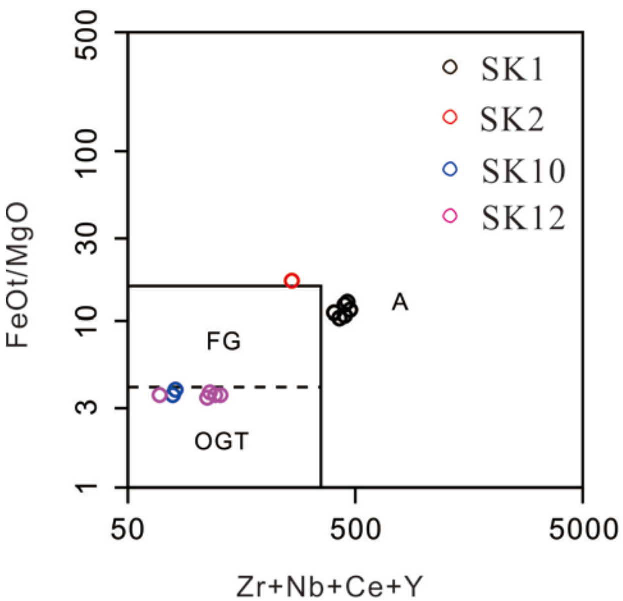
granite

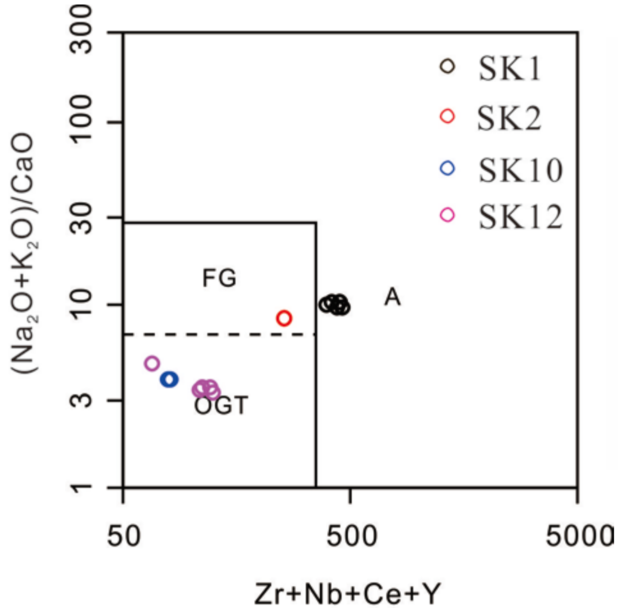
peraluminous

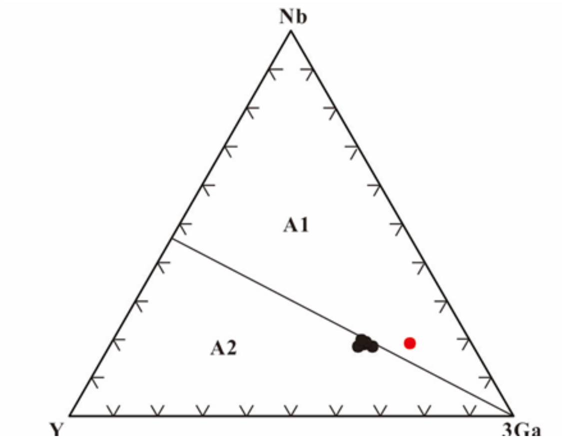




Research methods and results







Augengneisses plot mostly in the field of A-type granite

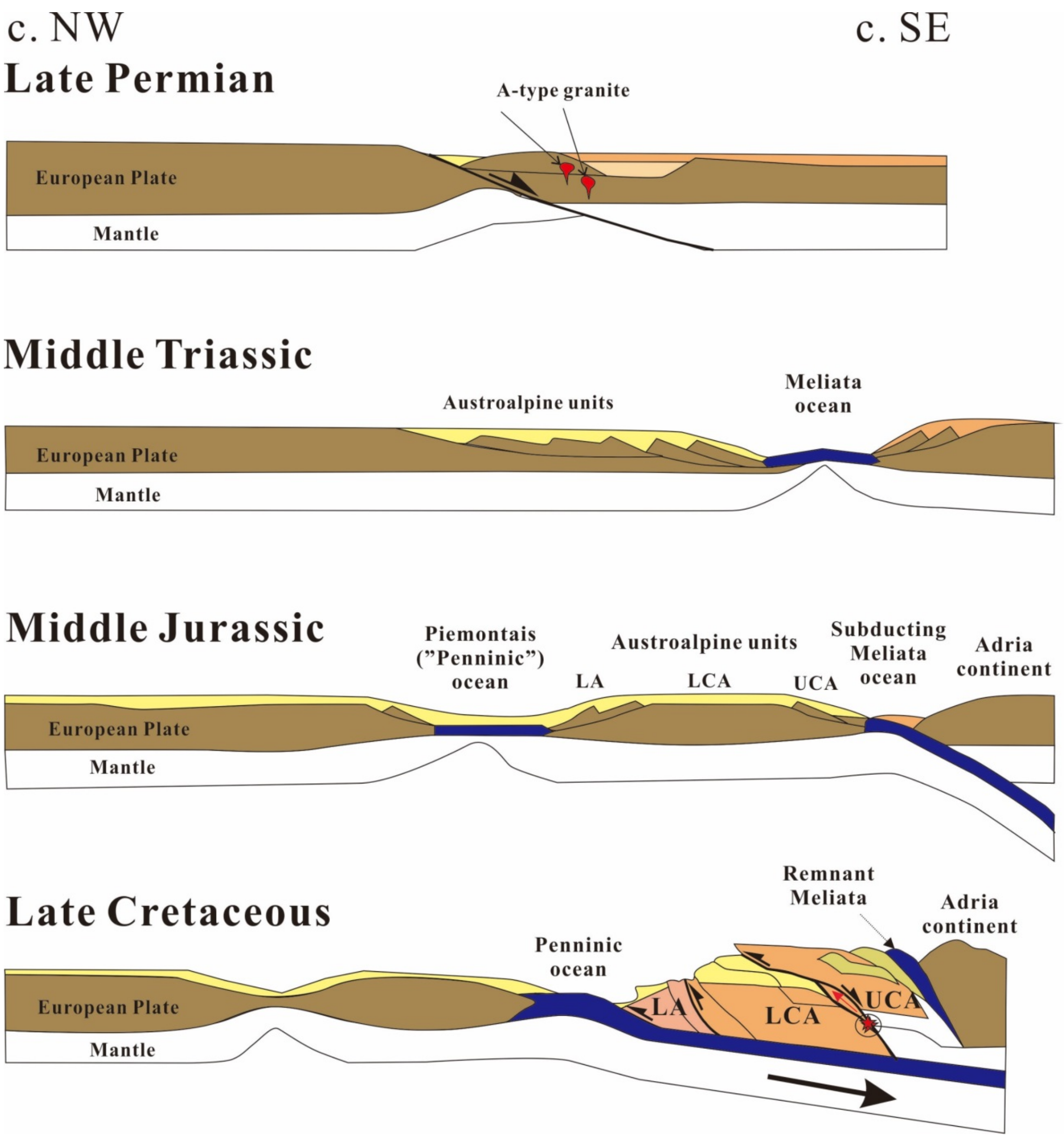
zircon U–Pb ages of the orthogneisses are 255±2.2 Ma and 260±0.81 Ma

The εHf(t) values of zircons are negative (-6.4 to -1.7)

high $(La/Lu)_N$ ratios, strong negative Eu anomalies

Augengneisses formed in a rift and lithospheric thinning setting in the Permian

Discussion and Conclusions



- Permian granitic to granodioritic intrusions was dated at 255–260 Ma and are derived from partial melting of lower continental crust in a rift zone.
- An intracontinental subduction zone formed within the Austroalpine continental crust at the site of a Permian rift.
- The segment of the EGU is part of the distal Permian rift zone, which finally led to the opening of the Meliata Ocean during Middle Triassic times. The stretched continental crust was subducted to mantle depth and then rapidly exhumed by upward motion due to buyoyancy during early Late Cretaceous times.
- We propose a new model for accretion of lower Middle/Lower Central Austroalpine and Lower Austroalpine by continuous downward motion of the Meliata oceanic slab.