

Geological Background



The Scandinavian Caledonides are composed of series of allochthons separated by major shear zone (e.g., Gee *et al.* 2008):

- Autochthon
- Parautochthon
- Lower Allochthon
- Middle Allochthon
- Upper Allochthon
- Uppermost Allochthon

The Seve Nappe Complex (Middle Allochthon) in the Kebnekaise region includes the Kebnekaise and Mårma terranes.

Kebnekaise terrane: comprises the Kebne Dyke Complex (KDC). The age of emplacement ranges between c. 608 to 596 Ma (e.g. Baird *et al.* 2014).

Mårma terrane: consists of the Väsåçorru Igneous Complex (VIC), Vieručohkka amphibolite (VA), and Leavasvåggi Gneiss.

Fig. 1. Geological map of the Kebnekaise Mts area Callegari *et al.* (in review); modified after Thelander (2009).

Petrography

Deformed *Vistas Granite* (VIC; **VST-10B**). Comprises mineral assemblage: Qz + Pl + Ms + Bt + Crd + Kfs + Grt ± Ilm. VST-10A is a felsic dyke intruding VST-10B.

VIC gabbro (**VST-8C**) intruded by a *granodioritic dyke* (**VST-8A**). Gabbro mineral assemblage is Pl + Cpx + Bt + Amp. VST-8A assemblage is Pl + Kfs + Bt + Qz + Cpx.

Mylonitic orthogneiss of the Leavasvåggi Gneiss (**KB17-14b**). Assemblage of Qz + Ky + Ms + Grt + Bt + Pl + Kfs ± Rt ± Gr.

Banded amphibolite (**GUO1**). Melanocratic layer: Amp + Ttn + Qz + Pl + Ms + Bt. Leucocratic layer: Grt + Pl + Qz + Ttn + Ep. White arrows indicating melt films around garnet.

Aurek metagabbro (**ARK-06; ARK-11**). The mineral assemblage is Grt + Amp + Opx + Pl ± Rt ± Cpx ± Ttn ± Ilm ± Qz. Ky-needles are found in Pl.

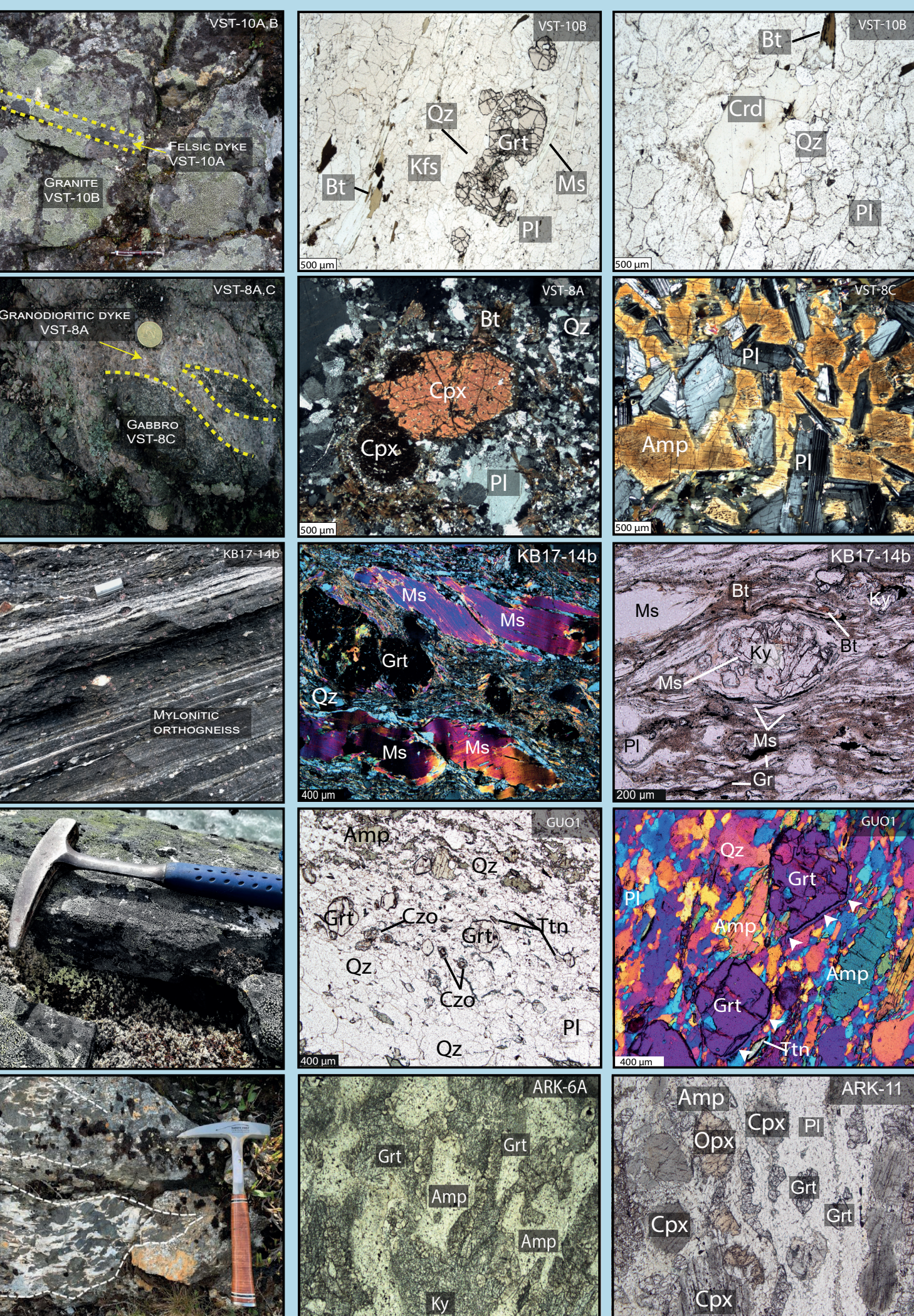
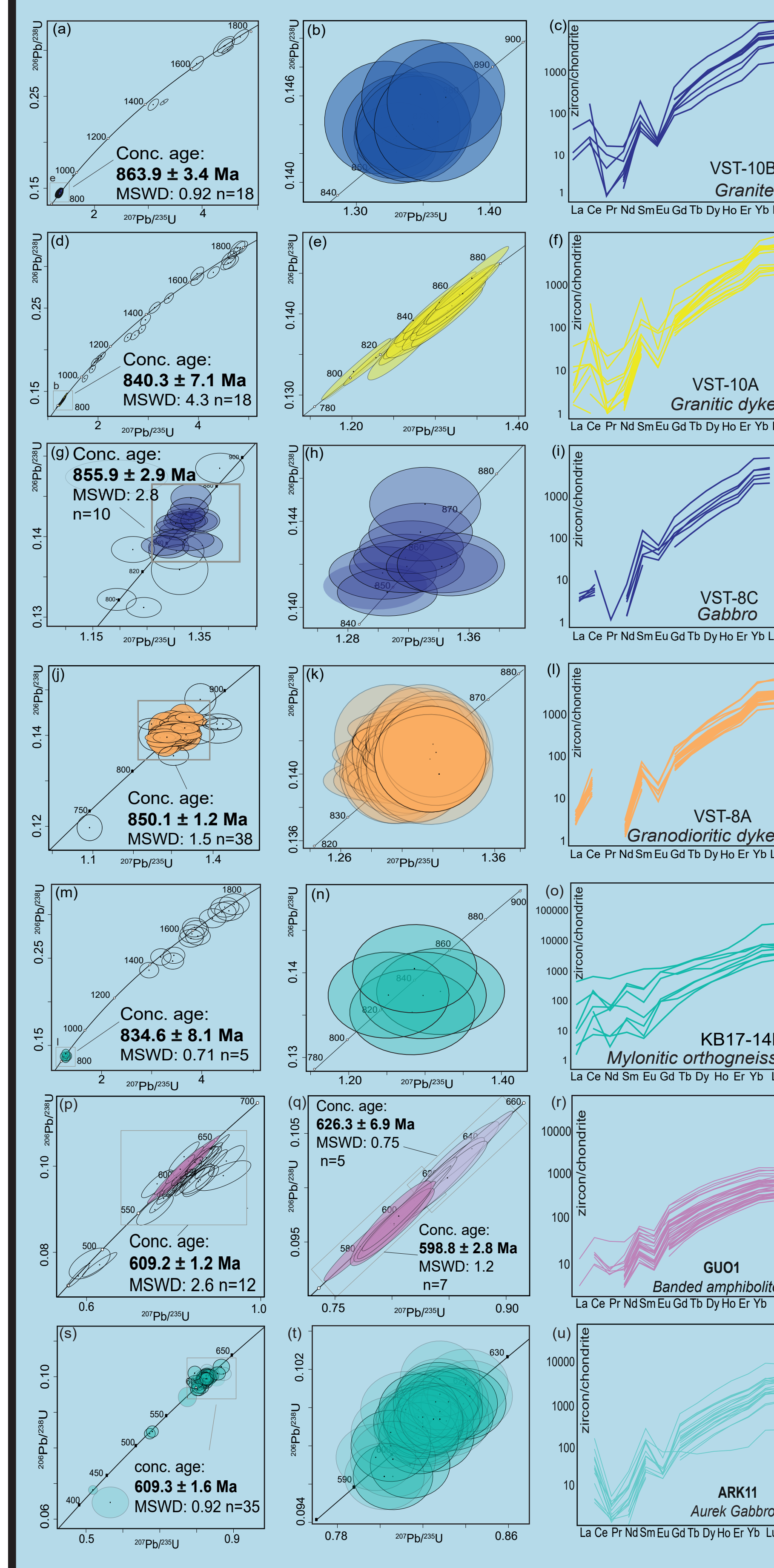


Fig. 2. Representative field pictures and photomicrographs of the studied samples. Mineral abbreviation after Whitney and Evans (2010).

U-Pb zircon geochronology



VST-10B: Eighteen rims define a Concordia age of **863.9 ± 3.4 Ma**. The HREE slopes are steep. The Th/U ratios range from 0.08 to 0.71.

VST-10A: Eighteen rims define a Concordia age of **840.3 ± 7.1 Ma**. The HREE slopes are steep. The Th/U ratios range from 0.02 to 0.70.

VST-8C: Ten zircons define a Concordia age of **855.9 ± 2.9 Ma**. The HREE slopes are steep. The Th/U ratios range from 0.67 to 1.37.

VST-8A: Thirty-eight zircons define a Concordia age of **850.1 ± 1.2 Ma**. The HREE slopes are steep. The Th/U ratios range from 0.18 to 0.79.

KB17-14b: Five rims define a Concordia age of **834.6 ± 8.1 Ma**. The HREE slopes are shallow. The Th/U ratios range from 0.02 to 0.47.

GUO1: Five zircons define a Concordia age of **626.3 ± 6.9 Ma**. Seven zircons define a Concordia age of **598.8 ± 2.8 Ma**. The Th/U ratios range from 0.33 to 0.83.

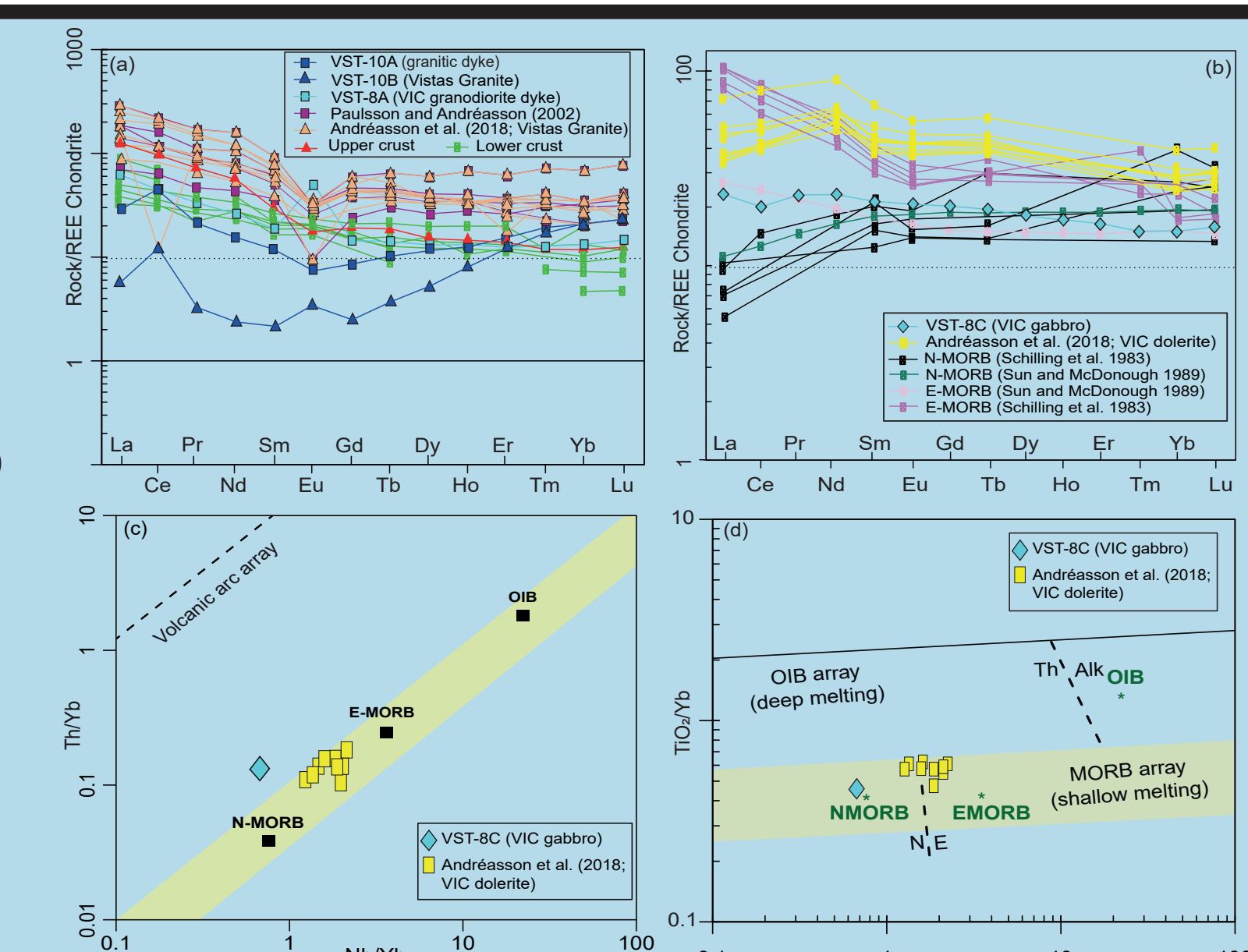
ARK-11: Thirty-five zircons define a Concordia age of **609.3 ± 1.6 Ma**. The HREE slopes are steep. The Th/U ratios range from 0.28 to 0.65.

Fig. 3. LA-ICP-MS results for U-Pb zircon geochronology. Wetherill concordia diagrams (left and middle columns); chondrite-normalized REE patterns (right column). (Callegari *et al.* in review; in prep.)

VIC Geochemistry

The VIC granitoids **VST-10A** and **VST-8A** display concave up REE patterns similar to the lower continental crust, as well as the LREE for the **VST-10B**. The VIC gabbro **VST-8C** shows a similar pattern to N-MORB composition, with enriched LREE. **VST-8C** trace element composition plots in the N-MORB field, with relative enriched Th/Yb ratio.

Fig. 4. Geochemical analyses of the VIC rocks Callegari *et al.* in review. *Vistas Granite* and dolerites samples from Paulsson and Andréasson (2002) and by Andréasson *et al.* (2018).



Pressure-Temperature-time Paths

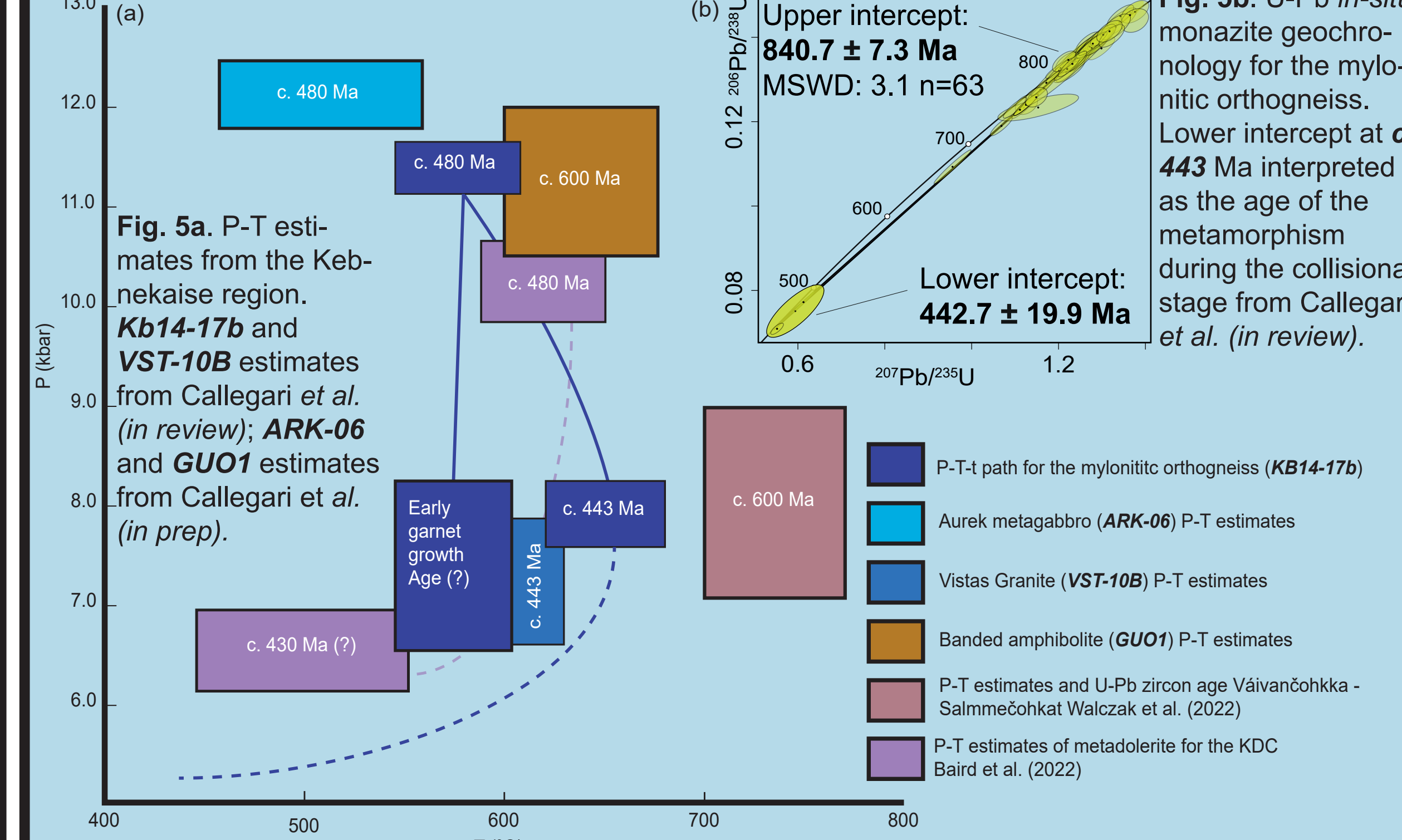


Fig. 5a. P-T estimates from the Kebnekaise region. **KB17-14b** and **VST-10B** estimates from Callegari *et al.* (in review); **ARK-06** and **GUO1** estimates from Callegari *et al.* (in prep.).

Fig. 5b. U-Pb *in-situ* monazite geochronology for the mylonitic orthogneiss. Lower intercept at c. **443 Ma** interpreted as the age of the metamorphism during the collisional stage from Callegari *et al.* (in review).

VIC P-T estimates were obtained combining phase equilibria modelling, conventional and trace element thermobarometry. The P-T results for sample **KB17-14b** define a clockwise metamorphic path. **GUO1** P-T estimates were obtained using conventional thermobarometry. **ARK-06** estimates are calculated using phase equilibria modelling.

Conclusions

- Geochronological results of the Väsåçorru Igneous Complex within the Mårma terrane indicate a prolonged extensional event between c. **864 Ma** and c. **835 Ma**.
- REE chondrite-normalized spider diagram for felsic samples indicate **melting of the lower crust**. The REE chondrite-normalized for the VIC gabbro displays **N-MORB affinity**.
- Geochronology and geochemistry suggest that the event responsible for the emplacement of the VIC is related to a **failed rifting attempt of Rodinia**.
- The banded amphibolite and Aurek gabbro are related to the real break-up and opening of the Iapetus Ocean. Dyke swarm ages range between c. **625 Ma** to c. **610 Ma**.
- The banded amphibolite records **high-temperature metamorphism** in the melt stability field at c. **600 Ma**.
- The Aurek metagabbro record **high-pressure metamorphic** condition at c. 480 Ma.
- **P-T-t path** for the Mårma terrane calculated for sample **KB17-14b**.

References

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Acknowledgements

This research is funded by the National Science Centre (Poland) project no. 2019/33/B/ST10/01728 to Majka.

