

Thi Quynh Anh Nong¹, Christoph A. Hauzenberger¹, Daniela Gallhofer¹, Sang Dinh²

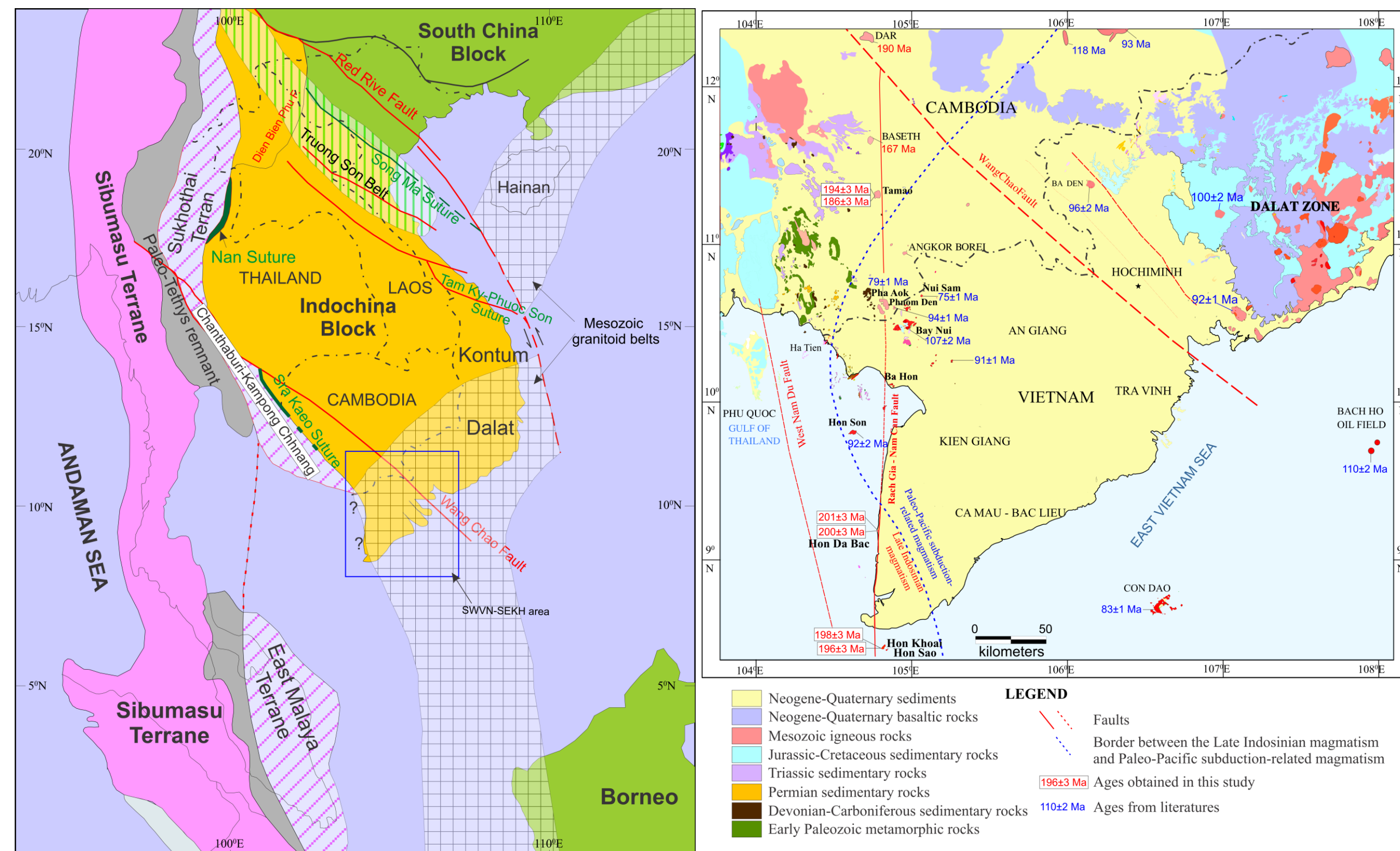
¹Institute of Earth Sciences, NAWI Graz Geocentre - Department of Petrology and Geochemistry, Graz, Austria

²Faculty of Petroleum, PetroVietnam University, Vietnam Oil and Gas, Vietnam

Introduction

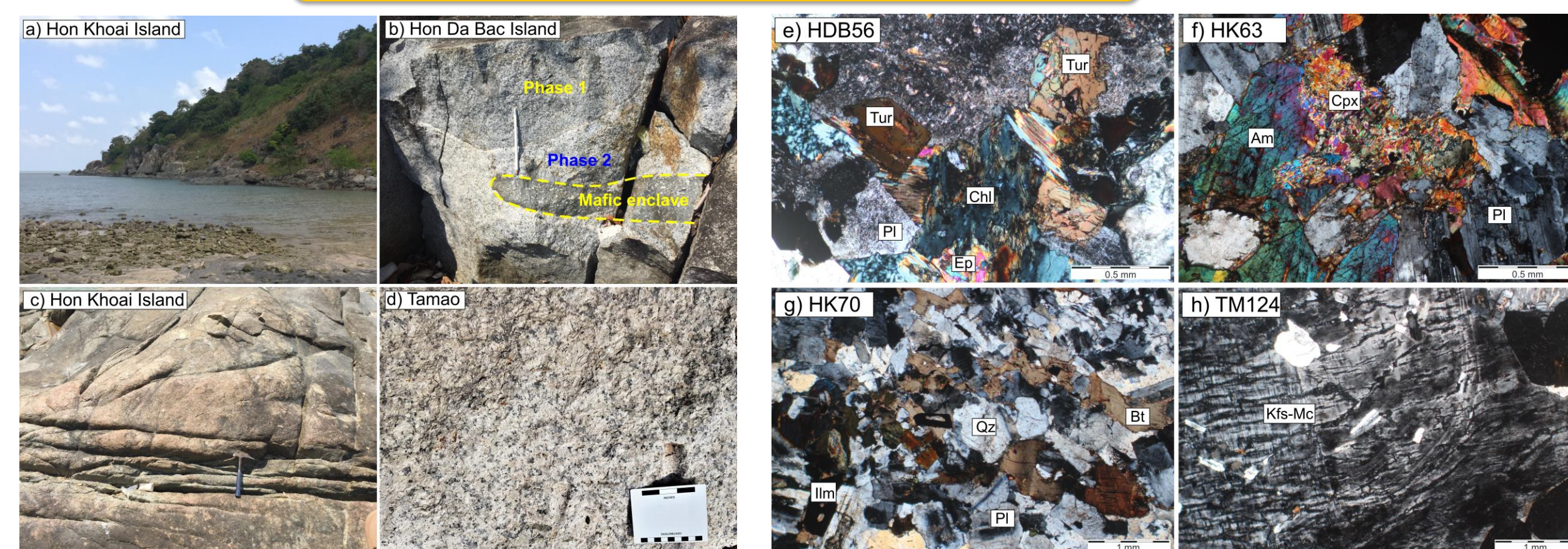
- Early Mesozoic magmatism in Indochina and its surroundings in Sundaland (SE Asia) has been usually ascribed to be in connection with one of three approximately coeval tectonic regimes: 1) the Indochina-Sibumasu amalgamation leading to the closure of the Paleotethys during the Late Paleozoic – Early Mesozoic forming **granite belts along the Sukhothai Terrane**, 2) the Indochina-South China amalgamation along the **Song Ma suture zone** closing another branch of the Paleotethys during Late Paleozoic – Triassic times, and 3) the early stage of an active margin with the **Paleo-Pacific subduction** during Triassic-Jurassic times (in SW Borneo).
- Scattered granitic plutons (**185–210 Ma**) located in southern Cambodia and some islands in southernmost Vietnam (hereafter SWVN-SEKH area) are distributed along the N-S Rach Gia-Nam Can fault. Three outcrop sites presented in this study are Hon Da Bac Island (Hondabac rocks) and Hon Khoai Island (Honkhoai rocks) of Vietnam and Phnom Tamao of Cambodia (Tamao rocks).
- Geochemical, U-Pb geochronological and geographical arguments point to a connection of the SWVN-SEKH area with granite belts along the Sukhothai Terrane.

Geological Setting and Fieldwork

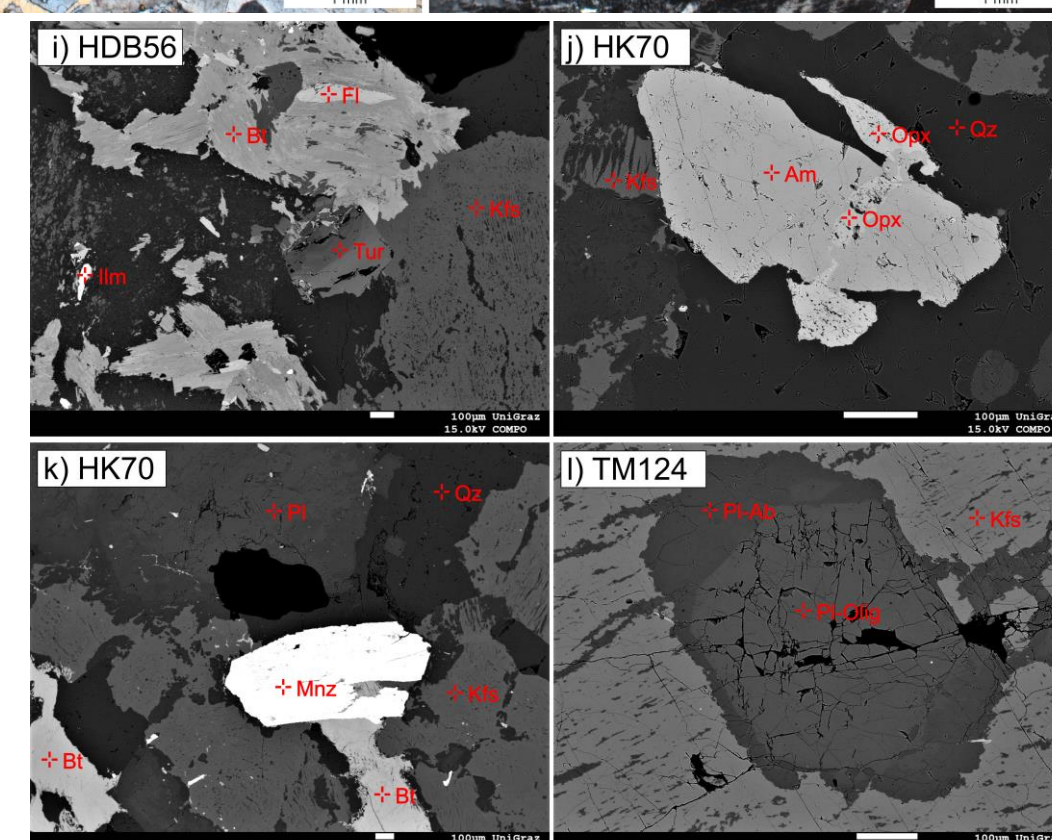


- Rocks from three outcrop sites are distributed along the N-S Rach Gia-Nam Can fault which is a large-scale fault active during the Early Mesozoic.
- The SWVN-SEKH area is located in the junction region of Early Mesozoic magmatism (Indosinian Orogeny) and Late Mesozoic magmatism (Paleo-Pacific subduction-related magmas).

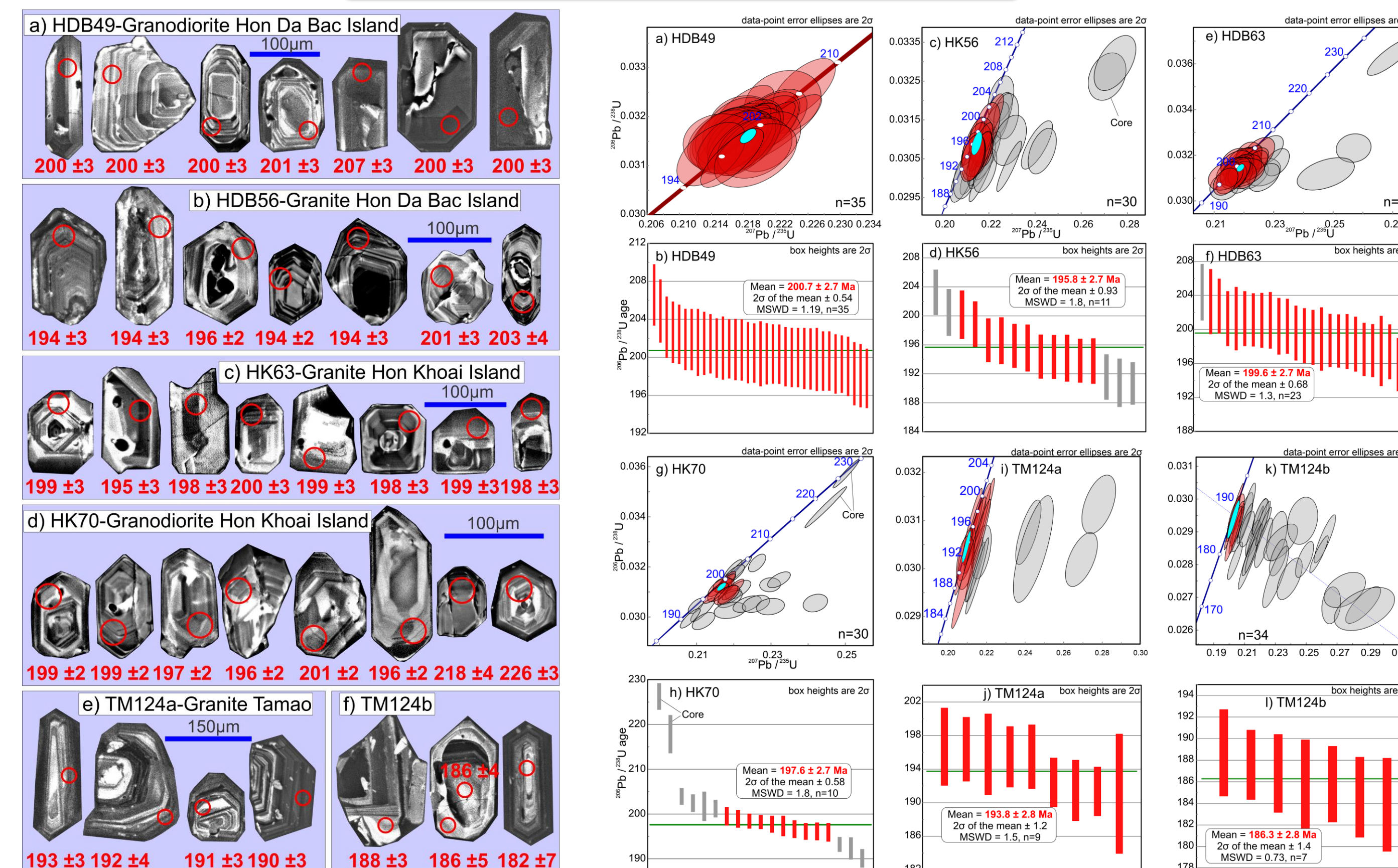
Petrography and Mineralogy



- Hon Da Bac Island** (HDB, Vietnam): biotite granite and subordinate tourmaline-bearing granite. Accessory minerals are tourmaline, ilmenite, apatite, fluorite, epidote, and titanite.
- Hon Khoai Island** (HK, Vietnam): Weakly foliated biotite-rich granites and biotite-amphibole granites. They usually contain amphibole relicts in biotite and remnants of pyroxene in amphibole. Accessory minerals are ilmenite and monazite.
- Tamao** (TM, Cambodia): Coarse-grained biotite granites are notably abundant in microcline and containing biotite aggregated with sporadic muscovite. Accessory phases consist of ilmenite, apatite, and fluorite.

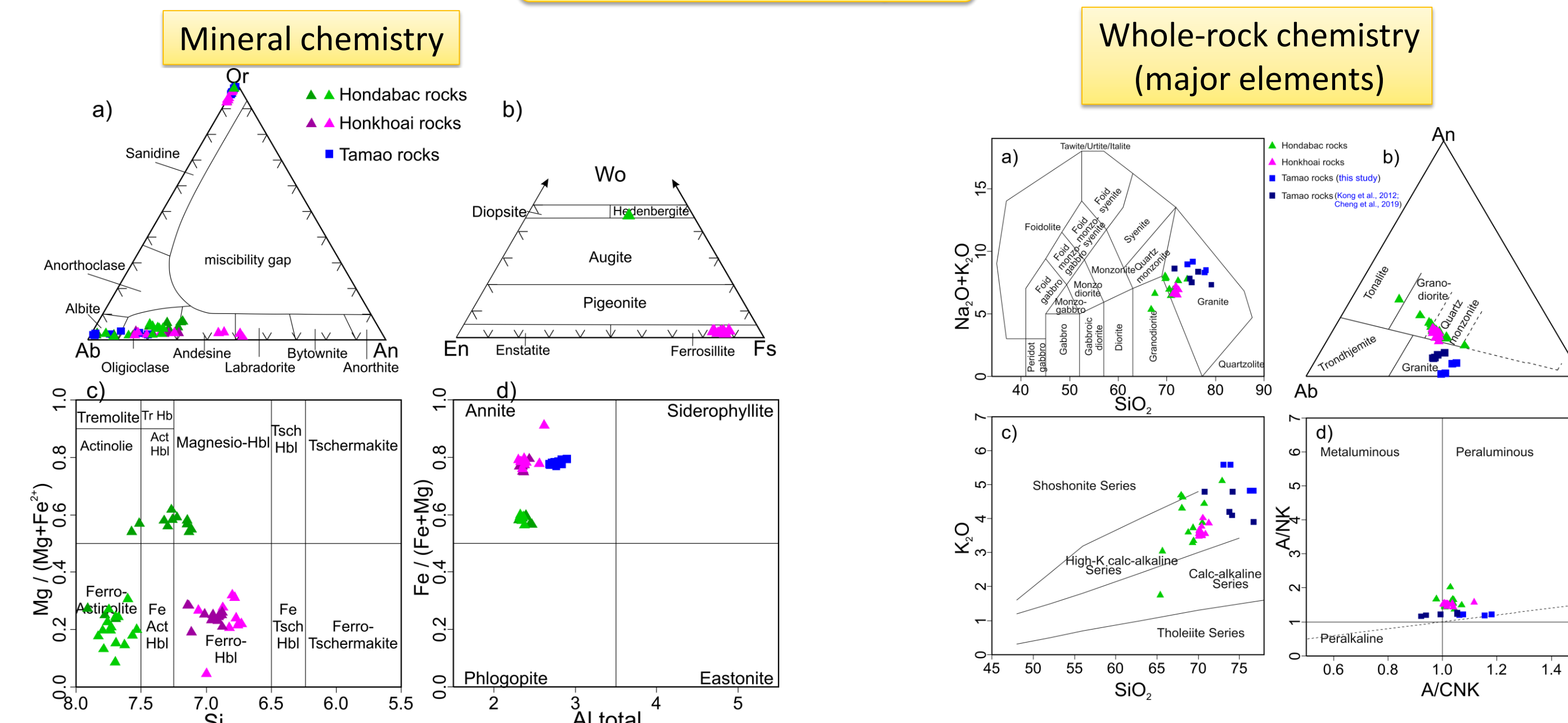


Zircon U-Pb Geochronology



- Zircons of the Hondabac and Honkhoai rocks** are usually euhedral and stubby prismatic, colourless to pinkish-orange, and transparent. They display oscillatory zonation typical for magmatic origin. Zircon inheritances are occasionally found with slightly older dates relative to the main zircon populations (sample HDB56 and HK70).
- Zircons of the Tamao rocks**, apart from the main group of euhedral and oscillatory zoned zircons, there are also opaque, porous, subhedral zircons showing bright cores overgrown by dark and thick rims, which suggest metamictization or recrystallization.
- U-Pb ages of the Hondabac and Honkhoai rocks are slightly older than the Tamao rocks. However, all granitoids in the studied area are chronologically coeval with all three tectonic events mentioned above.

Geochemistry



- Plagioclase is restricted in composition (andesine- albite).
- Pyroxene, amphibole, and biotite show a Fe-dominant composition indicating an evolved nature of the magma.
- Amphibole of the Hondabac rocks is Mg-rich compared to the Honkhoai rocks.

- Most of the rocks are high in silica content and belong to a high-K calc-alkaline trend.
- The Hondabac rocks are broader in compositional range compared to the Honkhoai and Tamao rocks.
- Harker diagrams show a decrease of MgO, FeO, CaO, Al₂O₃, P₂O₅, MnO, and TiO₂ with increasing SiO₂ indicating fractionation of pyroxene/amphibole, plagioclase, Fe-Ti oxides, and apatite.

Geochemistry

Whole-rock chemistry (trace and rare earth elements)

Trace and rare earth element pattern of rocks from SWVN-SEKH area are presented in the diagrams to the right. They overlap completely with granite belts along the Sukhothai Terrane and partly with the Paleo-Pacific subduction-related rocks from SW Borneo.

The chemical composition point to an arc-related tectonic setting for the Hondabac rocks, while the Honkhoai and Tamao rocks are ambiguous in constraining the tectonic regime but are likely close to a within-plate setting.

- Trace element composition is characterized in primitive mantle normalized spider plots by positive anomalies in Cs, Rb, Th, U, Ta and Pb and a negative one in Ba, Sr, Nb, P, and Ti. (Sun and McDonough, 1995).
- All analyzed rock samples show (La/Yb)_n values of 4.05–17.27 and pronounced negative Eu anomalies (Eu/Eu* = 0.15–0.65) (Boynton, 1984).

Emplacement condition

- Zr-saturation thermometry shows a crystallization temperature of the granitoids ranging between 713 and 839 °C.
- Emplacement pressure was estimated based on the chemical composition of Ca-amphibole. The obtained pressures yield 1.3–1.7 kbar for the Hondabac rocks and 1.7–3.0 kbar for the Honkhoai rocks.
- Igneous rocks emplaced under a moderate oxygen fugacity. The Hondabac magma is more oxidized compared to the Honkhoai magma based on the chemical composition of amphibole.

Geodynamic model and conclusion

- The Early-Middle Mesozoic igneous rocks in the SWVN-SEKH area were formed during the closure of the Palaeotethys along the western boundary of the Indochina block. They were emplaced coincidentally with the Indosinian Orogeny driven by accretion of the Sibumasu terrane to the Indochina–South China blocks.
- Geochemical and U-Pb geochronological characteristics of the studied rocks are similar to those of granite belts along the Sukhothai Terrane, particularly the Main Range Province granitoids. Hence, the Sukhothai-Chantaburi Terrane might be extended southeastward as far as to the Hon Khoai Island (southernmost Vietnam).

Cartoon showing the tectonic model is modified after Metcalfe (2017) and Searle et al. (2012) considering isotopic data of Cheng et al. (2019) and Ng et al. (2015a).

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