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Tracking Permian–Triassic tectonic transitions in Thailand via detrital zircon U-Pb ages, Hf isotopes and trace elements

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Time-integrated detrital zircon trace element (TE) data have proven useful to track crustal and mantle compositional changes, geodynamic variation, and Earth system evolution on a global scale. However, limited studies have applied detrital zircon TE datasets to reveal detailed, regional-scale complexities in subduction slab dynamics and changes in marginal tectonic regimes (e.g., transitions from subduction to collision). To assess its utility to track regional-scale complexities, we compare temporal variation in detrital zircon TE data from Thailand to relatively well-constrained tectonic reconstructions. ~2,500 detrital zircon U-Pb ages, Lu-Hf isotopic, and trace element datasets are present from river sands collected in Thailand that span the sutures across multiple terranes (i.e., Sibumasu, the Sukhothai Arc, and Indochina). The mean ratios of zircon Th/U, Nb/Ta are relatively high while the proportion of “felsic zircon” is relatively low during Permian extension of the Sukhothai Arc from Indochina and the formation of the Nan back-arc basin (ca. 295 Ma). During the Late Permian to Middle Triassic (255-235 Ma) the trench began to advance towards the Sukhothai Arc initiating closure of the Nan back-arc basin, and average values of zircon εHf(t), LREE/HREE, $(Eu/Eu^*)_N$, $(Ce/Ce^*)_N$, Nb/Ta and Th/U decrease whereas marked increases are displayed in Dy/Yb, U/Yb and the proportion of S-type granitic zircon. This illustrates a shift from dominantly metaluminous to peraluminous magma generation with contemporaneous crustal thickening. The overall increase in the proportion of felsic zircon during ~255–235 Ma also supports this shift from I-type to S-type magmatism, as S-type melts are generally more siliceous than I-types. Zircon εHf(t) from central Thailand shows a decrease during 255-235 Ma, whereas εHf(t) in zircon from Malaysia declines during 230-210 Ma, indicating that collision of southern Sibumasu with the Sukhothai Arc occurred ~20 m.y. later than in the north. These results demonstrate the promising utility of time-integrated detrital zircon TE data to reveal regional variability in the timing and nature of subduction dynamics and continental collision.