The Ailao Shan–Red River Shear Zone, NW Vietnam: A long-lived continental fault zone in SE Asia

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In SE Asia, the Ailao Shan–Red River Shear Zone (ASRR), stretching from Tibet to Vietnam, is located in the SW part of the South China Block. Its Vietnamese sector, exposed in the Day Nui Con Voi Massif (DNCV), occurs to the north of the Song Ma suture which developed during the Indosinian events in the Triassic. Our studies show that in the DNCV, the high-grade paragneisses and micaschists were intruded by granites, leucogranites and pegmatites in the Late Jurassic to Miocene times and repeatedly deformed. An integration of tectonic data and isotopic datings of some selected igneous rocks, the structural position of which was carefully identified, has revealed 4 tectonothermal episodes at 152–135 Ma, 80–70 Ma, 60–40 Ma, and 30–25 Ma intervals. During these episodes, the DNCV rocks were ductilely deformed by dextral wrenching, sinistral wrenching accompanied by vertical folds, dextral transpression associated with subhorizontal folds, and sinistral transtension accompanied by steep to low-angle normal faulting. These observations suggest multiple rejuvenation of the shear zone with changing kinematics. Although timing of an early dextral event is still unconstrained, it must have occurred under amphibolite facies conditions, prior to the intrusion of coarse-grained leucogranites at ~80–70 Ma. The felsic igneous rocks contain enclaves of country rocks with preserved pre-existing mylonitic fabric. Late Cretaceous magmatism affected rocks which were already sheared not less than twice. Detailed observations of the cross-cutting contacts, mesofabric and microfabric in mafic and felsic rocks revealed in several places that amphibolites became striped due to leucosomatic segregations and sheared at high temperature conditions. Migmatization went on at least partly in the dextral strike-slip regime. Leucocratic melts that were produced at 60–40 Ma were coeval with the last episode of high temperature metamorphism recorded by the DNVC rocks. The 60–40 Ma leucocratic rocks were then often zonally mylonitized in the strike--slip regime, with kinematic criteria indicating dextral over sinistral displacement overprints. Important information also comes from migmatitic amphibolites with pegmatitic granite neosome offsets oblique or normal to the foliation planes. The neosome bodies became subsequently sheared to gneisses and folded together with metabasites. Asymmetric, bivergent folds were formed in a transpressional regime. The contractional folding was accompanied by the reverse-type to vertical shearing located in or parallel to the short limbs of the folds. Such shearing led eventually to subvertical stretching and boudinage of the pegmatite veins. The transpressional deformation occurred under greenschist facies conditions as shown by chlorite tails or rims around hornblende porphyroclasts. Our observations show that the DNCV recorded complex and protracted tectonothermal evolution. In the Vietnamese part of the ASRR, rocks were high-grade metamorphosed, migmatized and sheared dextrally already by Late Cretaceous times at the latest. Accordingly, the ASRR is a polygenic feature in the South China Block, with protoliths of different ages and various records of multiple deformations throughout the Mesozoic and Cenozoic. Its polyphase tectonic history is evidently more complex than previously assumed and has likely reflected accommodation of dynamic interactions between crustal blocks in SE Asia since Carboniferous times. A crustal-scale response to India-Asia collision in the Tertiary seems to be only a part of this history.