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Geochronological and geochemical studies of mafic and intermediate dykes from the Khao Khwang Fold–Thrust Belt: Implications for petrogenesis and tectonic evolution

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ABSTRACT

Zircon U–Pb, mica 40Ar/39Ar ages and geochemistry of the Permo-Triassic mafic to intermediate dyke swarms at the south-western margin of the Indochina Terrane, central Thailand, are reported here and used to decipher the timing of the Sukhothai-Indochina & Sibumasu-Indochina collisions during the Permo-Triassic stages of the Indosinian Orogeny. The mafic dyke swarms in the folded layers of the Khao Khwang Fold–Thrust Belt (KKFTB) were emplaced between the Late Permian and the Late Triassic. The volcanic rocks range from slightly tholeiitic to mostly calc-alkalic, but can be subdivided into three different volcanic groups on the basis of trace and incompatible element abundances such as Ni, Cr, P, Co, and Th. However, all the groups present similar chemical footprints and are enriched in large ion lithophile elements (LILEs) (Rb, Ba, Sr, Pb) and light rare earth elements (LREEs), and depleted in HFSE such as Nb, and Ti highlighting the volcanic arc nature of the system. Isotopically, the three groups are characterized by subtle differences in $\varepsilon Nd(t)$ values (from +3.2 to +5.2) and initial 87Sr/86Sr ratios (from 0.7056 to 0.7067). The KKFTB mafic dykes share a few geochemical characteristics of the mafic dykes from the Chiang Khong volcanic suite in the Sukhothai terrane, and from the Loei volcanic belt in northern Indochina. These geochemical features suggest that the KKFTB mafic dykes, and the volcanic rocks in central-northern Thailand, were likely emplaced in a similar orogenic setting. The rocks of Group III are interpreted to have intruded from the Early Triassic (255 ± 6 Ma) to the Late Triassic (207 ± 2 Ma), and were probably sourced from a more crustally contaminated magma.

1. Introduction

The 'Indosinian Orogeny' broadly includes all the Late Palaeozoic to Early Mesozoic tectonic events related to closure of the eastern Paleo-Tethys Ocean (Cho et al., 2008). These events comprise collision of a succession of Gondwana-derived continental fragments, and volcanic arcs (Sone and Metcalfe, 2008; Metcalfe, 2013). In Thailand, the orogeny mainly developed during the Triassic and earliest Jurassic (Sone and Metcalfe, 2008; Metcalfe, 2011) and is the result of the collision between the Sibumasu, Sukhothai and Indochina Terranes (Fig. 1a). Models for the tectonic evolution of Thailand from the Indosinian Orogeny to the present have been defined using biostratigraphical, petrological, structural and geochronological data (Metcalfe and Sone, 2008; Sone and Metcalfe, 2008; Ridd and Morley, 2011; Morley et al., 2013; Arboit et al., 2014; Hansberry et al., 2014). However, a consensus on the location of the terrane boundaries, and nature and position of the relative suture zones has not been reached (Barr and Macdonald, 1991; Charusiri et al., 1994, 1997; Metcalfe, 2000). Volcanic rocks are an important tool able to provide fundamental information on the tectonic history of an area. Unfortunately, most of the volcanic and igneous rocks emplaced within central Thailand lack detailed petrochemical data and precise ages. This paper attempts to investigate the volcanic rocks and mafic dykes in the Saraburi area of central Thailand in order to understand the nature of the magma sources and the tectonic setting of their emplacement.

The igneous rocks studied are intruded within the Khao Khwang Fold–Thrust Belt (KKFTB) (Fig. 1b) and form a large igneous trend south of the KKFTB. This fold–thrust belt occupies an important position on the edge of the Nan-Sa Kaeo suture zone between Indochina and the Sukhothai volcanic arc, and are thought to correlate to the well documented volcanic bodies along the margin of these two terranes

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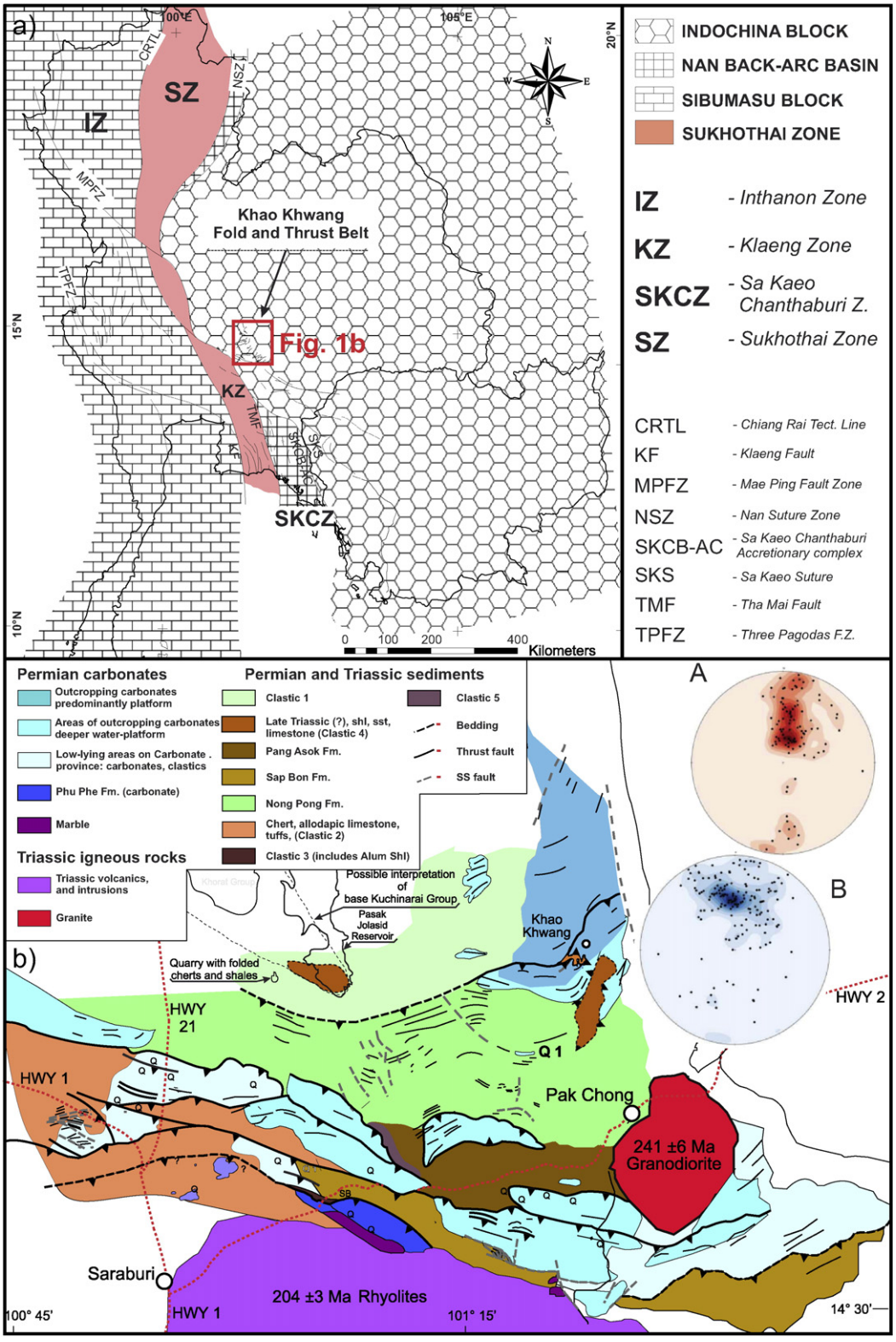

Fig. 1. a) Subdivision of Thailand into main tectonic terranes, that amalgamated during the Indosinian Orogeny (modified from Ueno and Charoentitirat, 2011), b) geological map of the Khao Khwang Fold and Thrust Belt. It has been modified from Warren et al. (2014) to show possible interpretations of the stratigraphy as a consequence of this study (a: poles to bedding within the KKFTB; b: poles to major thrusts and strike-slip faults in the southern portion of the KKFTB).

(Nakchaiya et al., 2008; Boonsoong et al., 2011) and in northern Thailand (Barr and Macdonald, 2000, 2006).

In this paper, we report new petrological data, 40Ar/39Ar mica and U–Pb zircon ages, along with both whole rock elemental and Sr–Nd isotopic data for representing dykes in the KKFTB with the aim to (1) establish an average crystallization age for the dykes, (2) unravel the origin and petrogenesis of the dykes, and, (3) constraining the compressional events affecting the Sukhothai and Indochina terranes