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The dextral strike-slip Khlong Marui Fault, southern Thailand

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Abstract: The Khlong Marui Fault, lying to the NNE of Phuket, has a strong geomorphic signal, with marked fault-strike parallel topographic ridges. The fault is ca. 150 km long with a 210-030º trend. The lithologies within the strike-slip zone mainly consist of vertical layers of mylonitic metapelites, migmatitic gneiss, mylonitic granite, pegmatites and cataclasites. The foliation and stretching lineations in ductile rocks indicate a dextral strike-slip displacement at mid- to upper-crustal levels. Pegmatites cross-cut the mylonitic foliation but are in turn sheared at their margins, indicating synkinematic emplacement. Although clear age-constraints are still lacking, the dextral strike-slip kinematics of the Khlong Marui fault is likely to be related to the escape tectonics arising from the India-Asia collision.

Keywords: mid-crustal deformation, strike-slip, Khlong Marui Fault, India-Asia collision, escape tectonics.

The Khlong Marui Fault, which is the southernmost of four major strike-slip faults in Thailand, is roughly 150 km long, NNE-SSW-trending from the Gulf of Thailand to the Andaman Sea (Fig. 1). The fault is an intra-plate strike-slip shear zone, up to 10 km wide, which is probably related to several other shear zones formed as a consequence of the India-Asia collision (Tapponier *et al.*, 1982, 1986; Polachan and Sattayarak, 1989; Polachan *et al.*, 1991; Huchon *et al.*, 1994; Leloup *et al.*, 1995; Lacassin *et al.*, 1997; Morley, 2001, 2002, 2007; Charusiri *et al.*, 2002). Despite the regional importance of this major structure, it has received scant modern structural attention (Garson and Mitchell, 1970; Garson *et al.*, 1975). Here, we present the kinematics of this mid- to upper-crustal shear zone, based both on a remote-sensing interpretation of the tectonic geomorphology and on detailed field-work.

Methods

The spatial distribution and orientation lineaments were quantified using remote-sensing techniques and compared with fault orientations and fault-slip data measured in the field. Aerial-photographs, Landsat TM satellite images and the SRTM digital elevation model were integrated in an ArcGIS geodatabase that was then used as a basic data set for quantitative spatial lineament interpretation. Structural field-work was difficult due to the poor level of exposure in the extremely dense jungle vegetation. Mylonitic foliations and lineations were measured and have been plotted on stereographic projections. Lineament orientations have been plotted in rose diagrams.

Lineaments

Based on remote sensing interpretations, three lineament orientations have been derived from different data

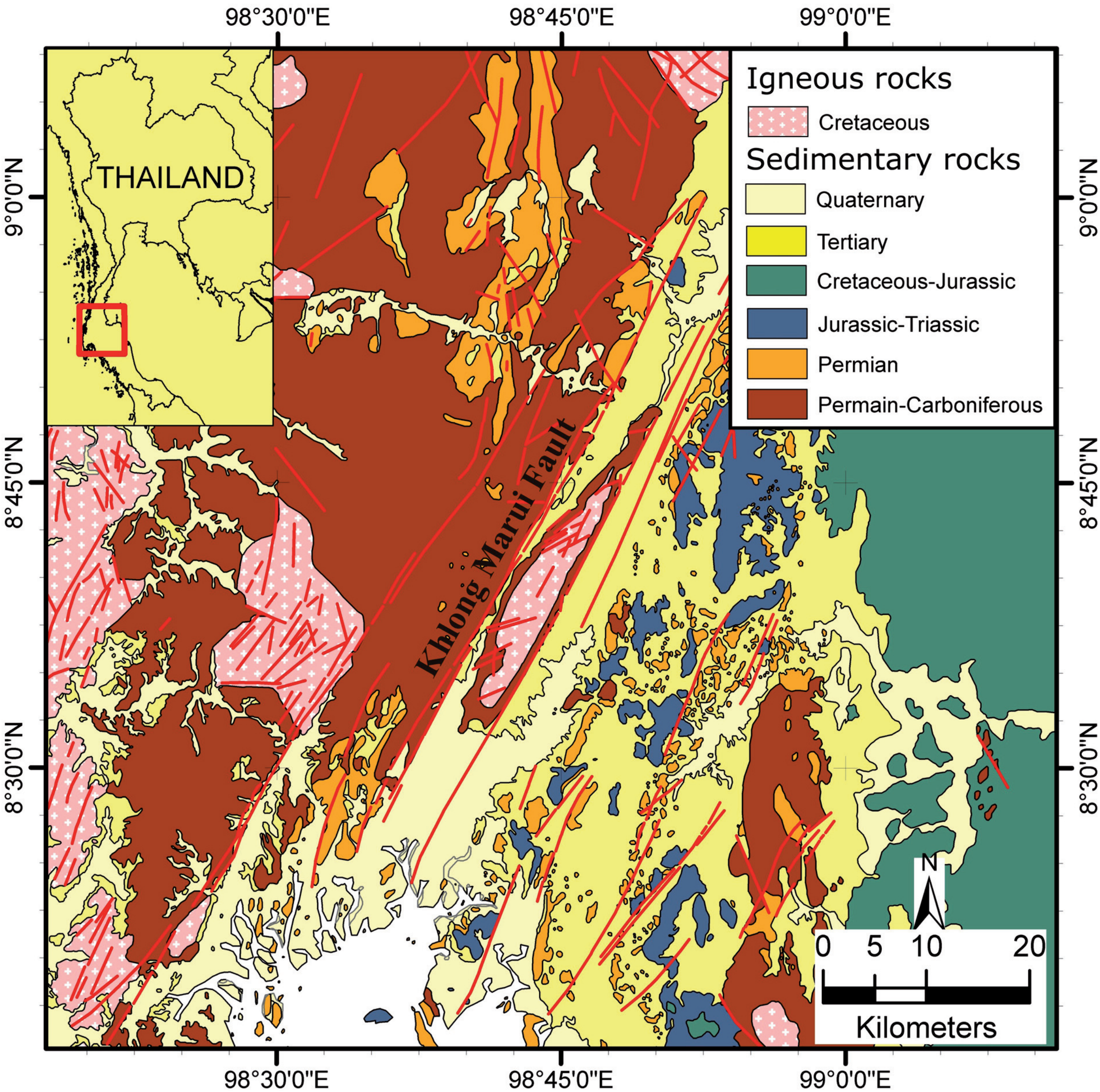

Figure 1. The southernmost Khlong Marui Fault represented by marked topographic ridges (modified from the geological map of Thailand, scale 1:250 000, 1982).

sources and the maxima statistically analyzed and plotted in rose diagrams. The main lineament directions derived from aerial photographs are 025-030°, 065-070° and 305-310° (Fig. 2a). Lineament data derived from Landsat TM satellite images showed maxima between 030-035°, 060-065° and 310-315° (Fig. 2b). Three main directions of 025-030°, 55-60° and 310-315° were also measured on the SRTM digital elevation model (Fig. 2c). When combined, the lineaments from all data sources gave major lineament directions of 025-030°, 60-65° and 310-315° (Fig. 2d).

The area mainly consists of low-grade clastic sediments belonging to the Permo-Carboniferous Kaeng Krachan Group. The rocks strike NNE-SSW, parallel to the marked topography, with steeply dipping to vertical foliation planes. Mylonitic metapelites in the area show evidence of strong non-coaxial deformation: abundant monoclinic quartz lenses, probably relics of stretched and rotated quartz veins, indicate dextral shear (Fig. 3). Cretaceous mylonitic granite and migmatitic gneiss appear at the centre of the shear zone, forming

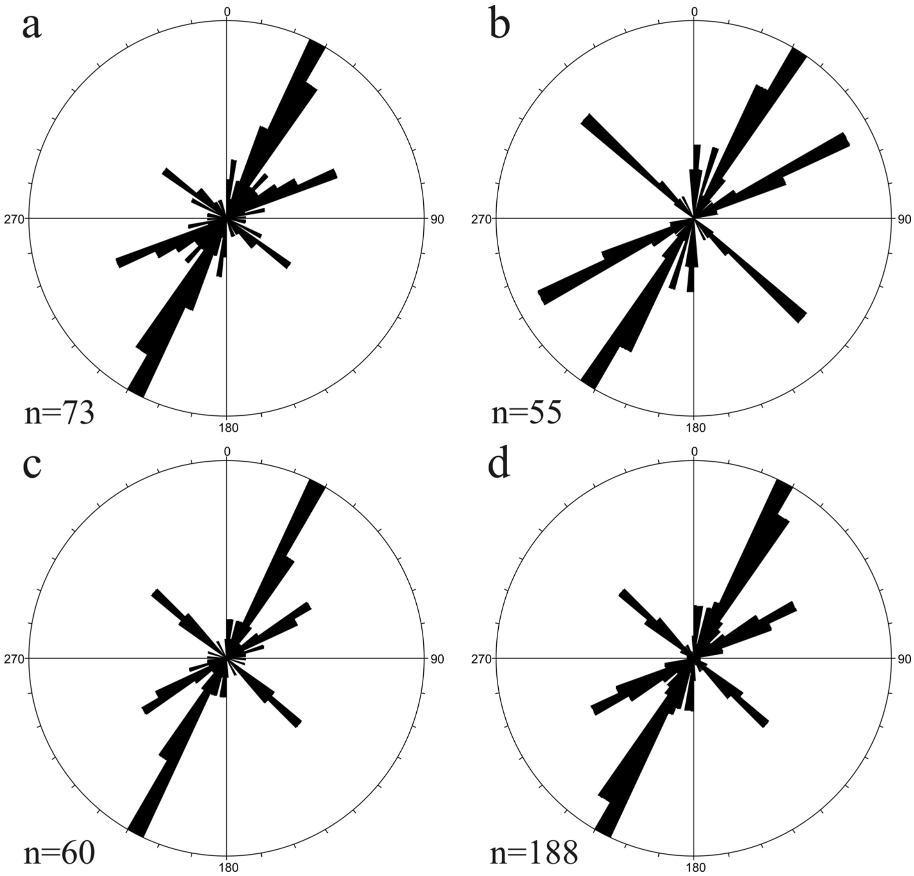

Figure 2. Rose diagram of lineaments from (a) aerial photograph, (b) Landsat TM satellite images, (c) SRTM digital elevation model, (d) synoptic.

topographic ridges parallel to the shear zone. Stereographic plots of the structural field-data show that the stretching lineations have a clearly defined NNE-SSW-trending maximum. The mylonitic foliation strikes NNE, dipping steeply to either the WNW or ESE (Fig. 4a). Brittle/ductile to brittle deformation is recorded in a pervasive joint-set striking predominately 285-290°NW and 295-305°NW (Fig. 4b). Cataclasites with vertical slickensides and slickenlines have been observed at the east and west margins of the shear zone, providing evidence of a component of normal faulting. Stereographic plots indicated that the major normal-faults trend is NNE-SSW (Fig. 4c).

Discussion and conclusions

Lineament trends

The three major lineament directions in the synoptic rose diagram can be statistically subdivided into one major and two minor domains (Fig. 2d). The maximum number of lineaments from the NNE-SSW striking 025-030° belongs to the major trend. The two minor lineaments are orientated at 060-065° and 310-315°. Both remote sensing and field data suggest NNE-SSW-trending fault domains which run parallel to the topography in the main fault zone. The minor ENE-WSW domain is probably an associated synthetic secondary fault system whilst the NW-SE directions may be interpreted as antithetic fractures related to the dextral strike-slip kinematics of the Khlong Marui Fault evolution.

Deformation history

Three stages of deformation have been tentatively recognized. Dynamically recrystallized quartz (mainly by basal gliding and subgrain rotation) confirms an early dextral strike-slip deformation in the fault zone, during low-grade ductile conditions. Contemporaneously with this ductile deformation at mid-crustal levels, pegmatite bodies intruded the shear zone, cross-cutting the early mylonitic foliation, but in turn themselves being affected by the ongoing ductile dextral shear. Deformation continued during subsequent cooling with dextral brittle movement and exhumation of the shear zone to

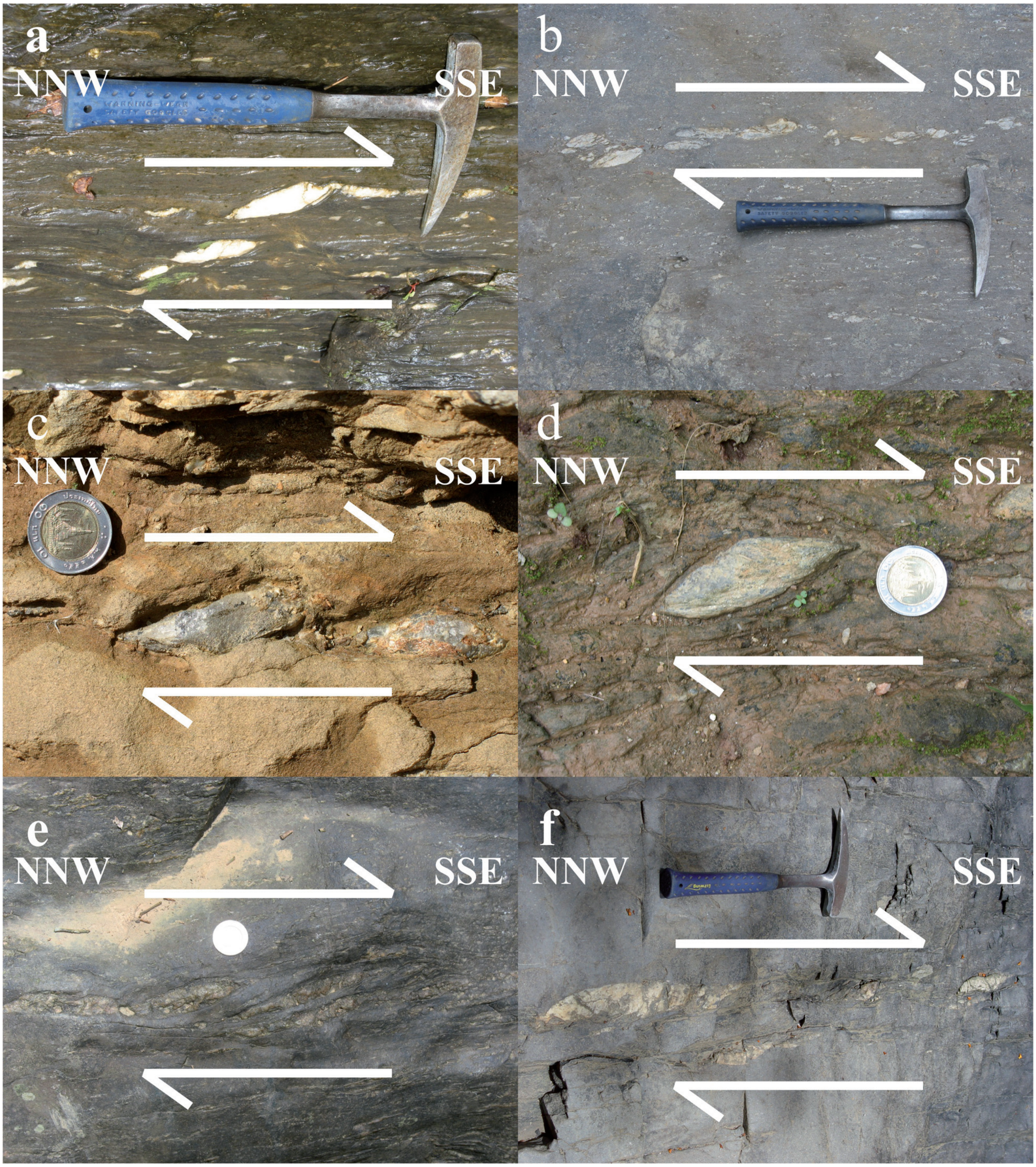

Figure 3. Ductile deformation of Permo-Carboniferous mylonitic metapelites appears in all area of the topographic ridge: (a) and (b) stretched pebble at the western part of the area, (c) and (d) quartz sigma-clasts along the road in the middle area, (e) and (f) dextral quartz shearing through the eastern area.

upper crustal levels. Finally, slickensides, found particularly along the eastern margin of the Khlong Marui Fault, attest to a normal component of fault displacement. The dextral strike-slip kinematics of the NE-striking Khlong Marui Fault can be geodynamically related to the conjugate shearing along NW-striking sinistral strike-slip zones such as Ailao Shan-Red River Fault, probably associated with escape tectonics arising from the Paleocene India-Asia collision.

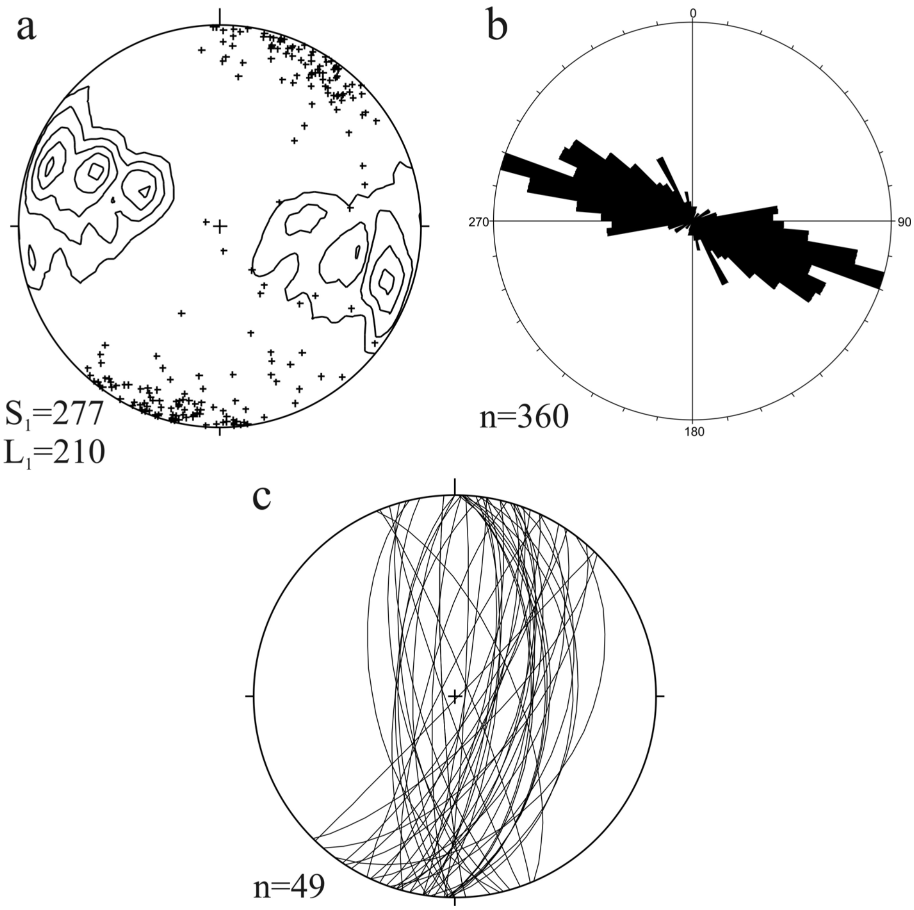

Figure 4. Equal-area lower-hemisphere stereographic projections of field data: (a) stereonet of foliations and lineations, (b) rose diagram of joint strike direction, (c) stereonet of fault planes and fault plane lineations.

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