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Chromian Spinel: An Indicator Mineral to Tectonic Setting of Thailand- A Preliminary Synthesis

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EXTENDED ABSTRACT

Approximately 100 chromian spinel grains from mafic/ultramafic igneous rocks and clastic sedimentary rocks at six locations of Thailand, were analyzed by electron microprobe (Akita University) to unravel tectonic setting of their host rocks. Most of the rocks were collected from five inferred geosutures of the country (Fig. 1), from east to west, as Loei Suture (Charusiri et al., 1997, 1999) in northeastern Thailand, Sra Kaeo-Chanthaburi Suture (Bunopas, 1992) in eastern Thailand, Nan-Uttaradit Suture (Barr and Macdonald, 1987) in northern Thailand, Narathiwat-Pattani Suture in the south (Charusiri et al., 1997) and Mae Yuam Suture (Ueno, 1999) in northwestern Thailand. Following petrogenetic studies on chromian spinels (Dick and Bullen, 1984), detrital chromian spinels have been also proved to be an excellent tracer for tectonic setting even in the area with poorly-defined geology (see Arai et al., 1997; Hisada et al., 1998; Bunyoungkul et al., 1999; Chutakositkanon et al., 1999). Our petrochemical and geochemical results on chromian spinels in ultramafic rocks from Thailand reveal that most of the spinels denote rather slight difference in Cr# [=Cr/(Cr+Al)] and TiO₂ contents (Fig. 2). Along the Nan-Uttaradit Suture in northern Thailand, TiO₂ content (~0.2-0.4 %) of chromian spinels from ultramafics in Nan area (north) is slightly lower than those (~0.35-0.48 %) of the ultramafics in Uttaradit area (south), but the Cr#s depict very slight difference (~0.6-0.8). However, along Sra Kaeo Suture in eastern Thailand, Cr spinels from ultramafics of Sra Kaeo area (north) show slightly lower Cr# (av. 0.65) than those of Wang Nam Yen area (south, 0.8-0.9), Nan and Uttaradit areas. However, TiO₂ contents of Cr spinels vary within the same range for those rocks in both Nan-Uttaradit and Sra Kaeo Sutures, except for those of the Sra Kaeo area where average TiO₂ content is about 0.05 %. For the southern Thailand's suture, Cr spinels for the Narathiwat area depict the values of Cr# around 0.8-0.9 % and variable TiO₂ contents between 0.3 and 0.55 %. In addition, we discovered two areas where detrital chromian spinels were observed in clastic sequences, one in the northeast and the other in the northwest. The analyzed samples are derived from sandstones of Permian Nam Duk Formation, NE Thailand and Middle Triassic Mae Sariang Group, NW Thailand. The Cr spinels of Mae Sariang rocks (Fig. 3) yield much lower TiO₂ content (av. 0.1-0.2 %) and illustrate the compositional span of Cr# (0.4-0.75). The Nam Duk Cr spinels are relatively high both in Cr# (0.5-0.8) and in TiO₂ content (up to 1 %). Based upon our preliminary results, it is visualized that detrital Cr spinels from both clastic units possibly lie within the fields of island-arc and fore-arc regions, respectively. Although the former can be placed overlapping within the ocean-floor field. This suggests that these two rock units, though contrasting in ages, may have occurred within the compressional tectonic regimes related to probably subduction zones. Geochemical results of the Cr spinels from mafic/ultramafic rocks from the Nan-Uttaradit, Sra Kaeo, and Narathiwat-Pattani Sutures, illustrate the quite similar pattern. Their plots are distributed within the field of island-arc setting. Although it is quite difficult at present to give some constrains for the ages of these sutures, the Early Carboniferous age by K-Ar method was reported from volcanics within the Nan-Uttaradit Suture (see Helmcke et al., 1985) and by ⁴⁰Ar/³⁹Ar approach for those rocks near the Loei Suture (Intasopa and Dunn, 1993). In Sra Kaeo and Wang Nam Yen areas, our field investigations demonstrate that the mafics/ultramafics are overlain by Permian shallow-marine fossiliferous limestones. We, therefore, infer that the age of these igneous rocks is very likely Carboniferous or at least pre-Permian. In area north of Chiang Rai, mafic/ultramafic rocks are investigated petrologically to indicate ocean-floor facies. Again their ages of volcanics are placed around Carboniferous due to their stratigraphic positions underlying the Permian carbonates. To the north-central part of the country (Pichit and Phetchabun areas), our field investigation together with subsurface drillhole data (Praditwan, per. comm.) reveal that volcanic and volcanoclastic facies are the predominant rocks underlying shallow-water fossiliferous Permian limestones. Evidences of arc-trench tectonic environments are inferred by the occurrence of Late Paleozoic to Early Mesozoic deep-water radiolarian-bearing cherts and siliceous shales with associated volcanics in Sukhothai area (Sashida and Nakornsri, 1997) almost within the so-called Nan-Uttaradit Suture, Sra Kaeo and Chantaburi in eastern Thailand (Sashida et al., 1999) close to Sra Kaeo Suture, areas close to Loei Suture (Sashida et al., 1993), and Fang and Chiang Dao areas (Caridroit, 1993) very close to the so-called Chiang Mai Suture. With these lines of evidence, particularly those of our petrochemical results on Cr spinels, we consider that there must be the poorly exposed paleo-oceanic crust lying in between Shan-Thai (W Thailand) and Indochina (NE Thailand). Air-borne geophysical data (Tulyatid and Charusiri, 1999) along with our satellite-borne image and structural syntheses strongly support this scenario. This oceanic lithosphere is a well-defined document for

the extensive appearance of the region-wide Paleotethian seaway which may have formed during Devonian to Carboniferous Periods. This paleotethys oceanic lithospheric plate (the so-called Nakhon Thai plate, see Charusiri et al., 1997) was subsequently subducted as the east-dipping lithospheric slab beneath Indochina plate, as well-documented in Loei, Nam Duk, and Sra Kaeo areas in the east. To the west, our data on the chromian spinel are still in progress, and evidences of sutures (Chiang Mai Suture) are supported by the boundary between voluminous Middle-Late Triassic granitoid rocks of S-type affinity with Sn-W-REE mineralization to the west of Chiang Mai and of I-type affinity with Sb-Au-W-Cu-Fe mineralization to the east of Chiang Mai (see Charusiri et al, 1993) and Permo-Triassic east-dipping poly-magmatic arcs (Charusiri et al., 1999). These evidences place the N-trending Chiang Mai suture closely corresponding to Fang, Chiang Mai and Sam Ngao basins and presumably extending southward to central Thailand across the Mae Ping and Three Pagoda Faults along the western edge of the Chao Praya River basin in Uthai and Kanchanaburi areas. Therefore to the west of this suture is the Shan-Thai plate and to the east of it is the Lampang-Chiang Rai plate. In addition, we cannot rule out the significant appearance of detrital chromian spinels in the Mae Sariang area close to the Mae Yuam Suture (see Ueno, 1999). However, more detailed investigations on geology and Cr spinel spinels are required to disclose clearly the tectonic history within the western and northwestern regions, especially those immediately close to the Myanmar border.

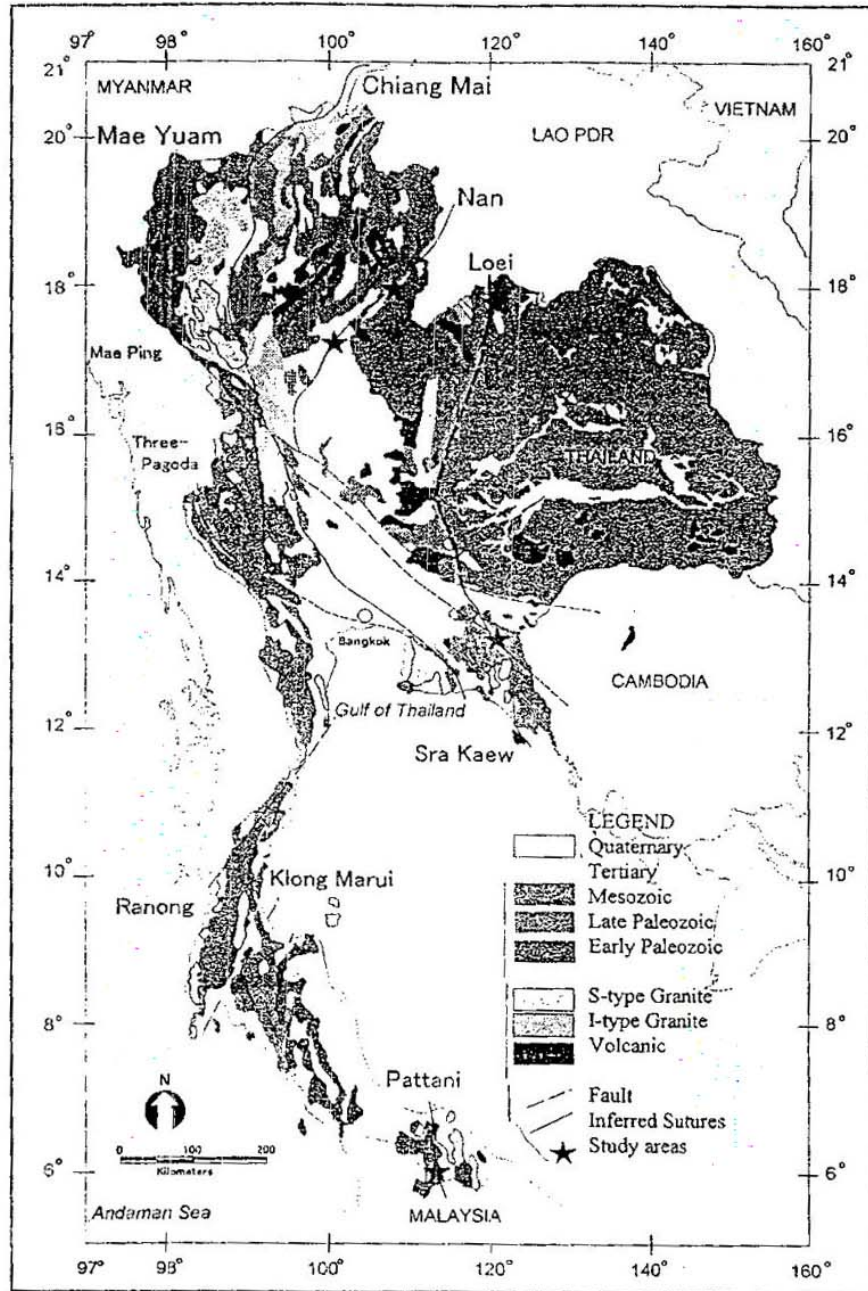


Figure 1 Geotectonic subdivisions of Thailand with simplified geology and locations of samples with chromian spinels.

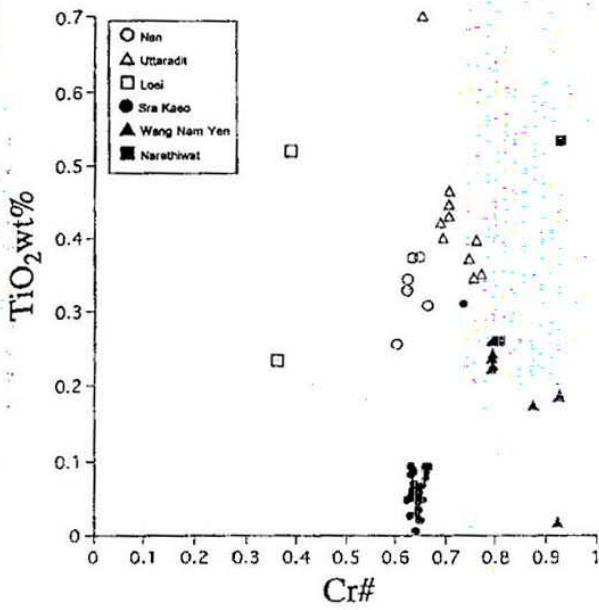


Figure 2 Diagram of Cr# versus TiO_2 showing plots of Cr spinels from mafic/ultramafic rocks of the Nan, Uttaradit, Loei, Sra Kaeo, Wang Nam Yen and Narathiwat areas.

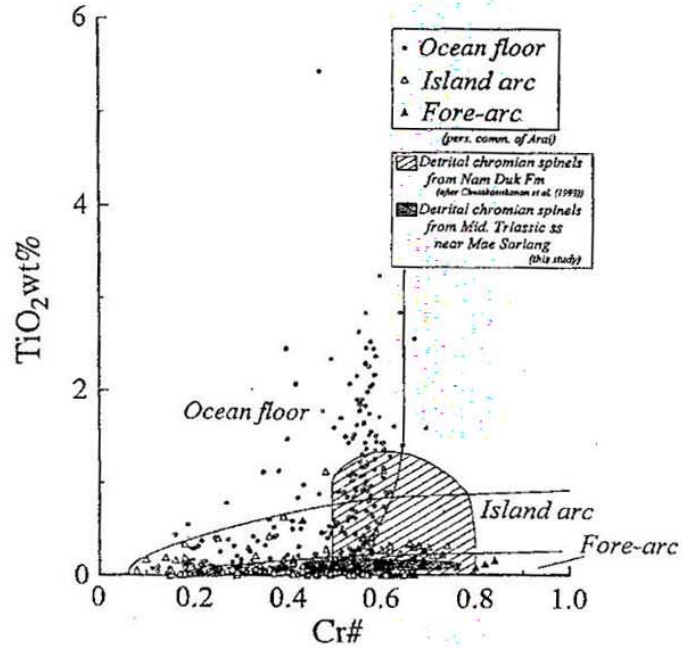


Figure 3 Fields of Cr# versus TiO_2 of the Name Duk and Mae Sariang sandstones in comparison with those of ocean, floor, island arc, and fore-arc mafic and ultramafic rocks of Arai (pers. comm.).

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