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Devonian radiolarians and tentaculitids from central Laos

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ABSTRACT

A 4 m thick section of silicified shales from Ban Phonxai in central Laos contains the radiolarians *Trilonche davidi*, *T. hindea*, *T. minax*, *T. palimbola*, *Stigmosphaerostylus* spp. and *Ceratoikiscum* ? sp. and the tentaculitids *Homoctenus ultimus* and *Costulatostylionina vesca* which together indicate a Frasnian age. This pelagic, deep shelf fauna from the Indochina Terrane is similar to that from South China and shows that tentaculitids may be common and biostratigraphically useful in radiolarian cherts and shales in South East Asia. This discovery probably necessitates mapping of the Late Devonian Phon Tiou Fm in this area which is currently mapped as the Early Carboniferous Boulapha Formation.

1. Introduction

Although Devonian sequences and faunas have been known in central Laos (Lao Peoples' Democratic Republic or Lao PDR) for many years, very few fossils have been described, figured and published (Saurin, 1958; Tong-Dzuy et al., 1996). The last publication on an invertebrate fossil fauna from this area was a description and illustration of some Devonian, Carboniferous and Permian corals by Fontaine (1961). This is the first, of a series of papers which will figure, describe and assess the Palaeozoic faunas of the Indochina Terrane (Fig. 1).

2. Regional geology and stratigraphy

In the 1990s the geology of central Laos was intensively studied by a team of Laotian and Vietnamese geologists based at the INTERGEO centre in Hanoi, who mapped the region on a scale of 1:200,000 (Tran et al., 2000a,b) and made important palaeontological discoveries and published many provisional faunal and floral lists (Tran, 2000). The INTERGEO team established and mapped a sequence of poorly outcropping, generally NW–SE striking strata, mainly siliciclastic, Palaeozoic formations which range in age from the Ordovician to the Early Carboniferous (Fig. 2). These strata generally dip towards the SW and SSW and are found in small roadside exposures, stream sections and quarries. The Ordovician to Early Carboniferous sediments are mainly siliciclastics, dominated by shales, silicified shales and silty sandstones with a few beds of arkose and limestones and limestone lenses. The limited exposures, tropical weathering and lithological similarities between the formations make mapping difficult and reliance has been made on the sporadic evidence of macrofossils for stratigraphic correlation and mapping. In contrast, the overlying Late Carboniferous to Permian limestones of the Khammouan Formation occur as spectacular tower karst features, are macro- and micro-fossiliferous and are easily mapped. The Khammouan Formation carbonates are in turn overlain unconformably by a thick Triassic to Cretaceous sequence of siliciclastics belonging to the Ling Kho Fm and the Nam Theun Group (Fig. 3).

The Ordovician to Devonian stratigraphy of Lao PDR has been well established around the Sepon copper–gold mine which is just to the south of our sampling area (Smith et al., 2005). Eight formations have been thoroughly mapped and studied at the surface and in numerous subsurface cores by company geologists, consultants and students (Fig. 3). Of these, Formation 7 consists of finely laminated, black to dark brown non-calcareous, organic rich, mudstone and chert containing layers that contain abundant pyrite and pyrrhotite. The black shale of Formation 7 contains abundant tentaculitids and other faunal elements of Frasnian age and may be correlated with our samples from further north. Samples for radiolarian, conodont and macrofossil work were collected from numerous silicified shale and shale localities in the Lao provinces (kwaang) of Bolikhamxai, Khammouan and Savannakhet (Fig. 2) from about 18.5° to 17°N. Macrofossils were found at Lak Xao (which translates as Kilometer Post 20), Ban Nam Phao and Ban Phonxai (also transliterated as Ban Phon Sai).

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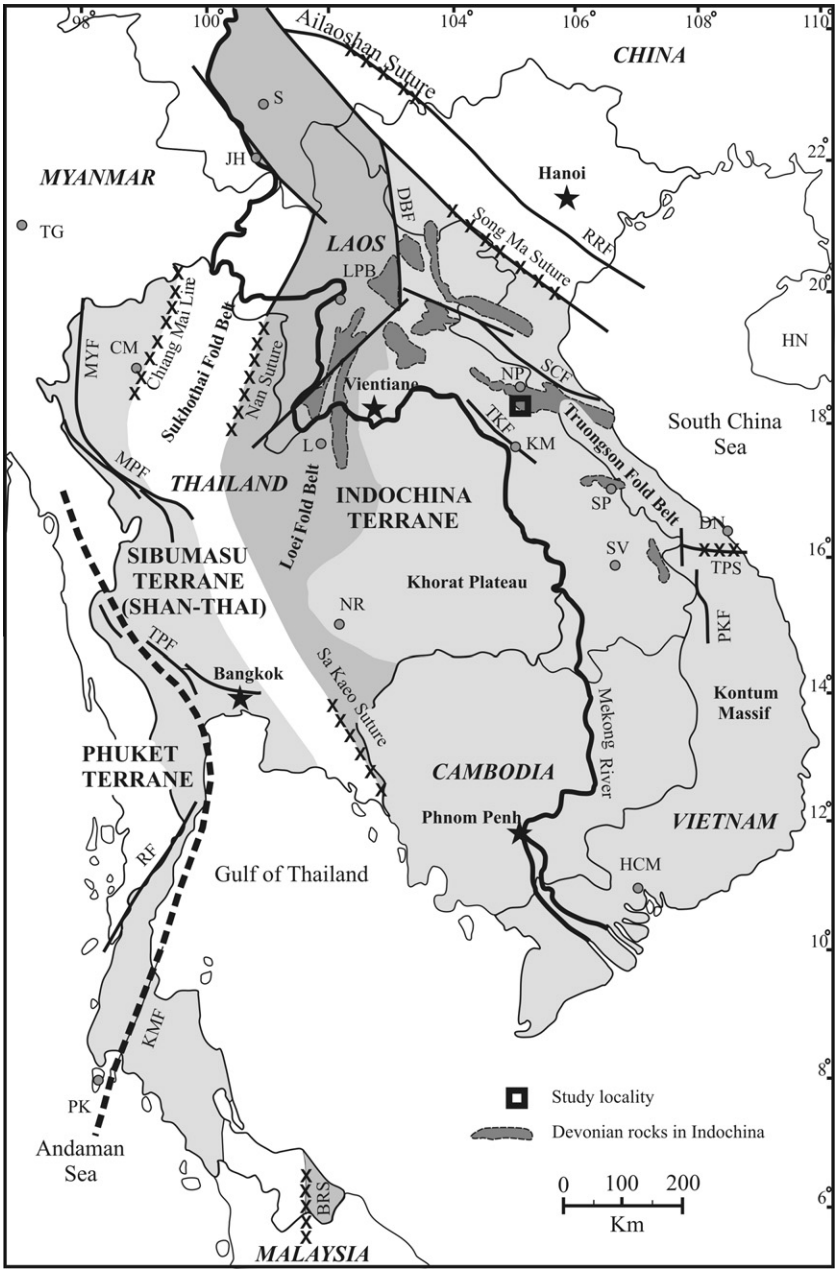

Fig. 1. Simplified tectonic map of Southeast Asia showing generalized distribution of Devonian sedimentary sequences on the Indochina Terrane. BRS = Bentong–Raub Suture, CM = Chiangmai, DBF = Dien Bien Phu Fault, DN = Danang, HCM = Ho Chi Minh City, HN = Hainan Island, JH = Jinghong, KM = Khammouan, KMF = Klong Marui Fault, L = Loei, LPB = Luang Prabang, MPF = Mae Ping Fault, MYF = Mae Yuam Fault, NN = Nanning, NR = Nakon Ratchasima, NP = Nape, Pk = Phuket Island, PKF = Poko Fault, RF = Ranong Fault, RRF = Red River Fault, SCF = Song Ca Fault SP = Sepon Mine, S = Simao, SV = Salavan, TG = Taunggi, TKF = Tha Keak Fault TPF = Three Pagodas Fault, TPS = Tamky Suture, V = Vinh.

One small, overgrown, roadside section of spotted, thinly bedded (1–2 cm thick) silicified shales was sampled at Ban Phonxai at an altitude of 504 m (1653 feet) and latitude 18°06′41.81″N longitude 105°02′05.83″ and UTM 0503698E, 2002414N. The dip is generally SSW to about 195° at 68° (Figs. 4 and 5). Macroscopically, the section contains small, poorly preserved brachiopods and tentaculitids. Microscopically the processed samples contain moderately preserved silicified tentaculitids and numerous, poorly preserved radiolarians. Small smooth ostracods, sponge spicules, fragmentary polygnathid conodonts and rare trilobites are also present.

3. Materials and methods

Twelve silicified shale samples from the Ban Phonxai section (PS1001–PS1012) were collected during field investigations in December 2010. Microfossils were extracted by the chemical method adapted from Pessagno and Newport (1972). The samples were crushed into small fragments (several centimetres) and soaked with diluted hydrofluoric acid solution for at least 24 h. These samples were then placed into plastic containers and covered with dilute hydrofluoric acid solution (5–10% HF) for 24 h at room temperature. The samples were washed and the residue passed through a standard sieve with mesh size 45 μm. This process was repeated at least 20 times until enough specimens were obtained. Radiolarian tests and tentaculitids from dried residues were picked under a stereomicroscope and selected radiolarian tests and tentaculitids photographed by Scanning Electron Microscope (SEM). Extraction and SEM photography was carried out at the Faculty of Science, Mahasarakham University (MSU). All specimens are deposited