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The Changning–Menglian suture zone; a segment of the major Cathaysian–Gondwana divide in Southeast Asia

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palaeomagnetic studies for limited if any separation of the continental masses (Lin and Watts, 1988; Smith, 1988; Lin and Fuller, 1990).

Smith (1988), concentrating on late Palaeozoic faunal distributions, concluded that, what he

termed the Cathaysian composite continent, formed a single biotic region. To Smith, the Cathaysian region comprised the North and South China blocks, and much of what is now Southeast Asia including the Indochina and Sibumasu

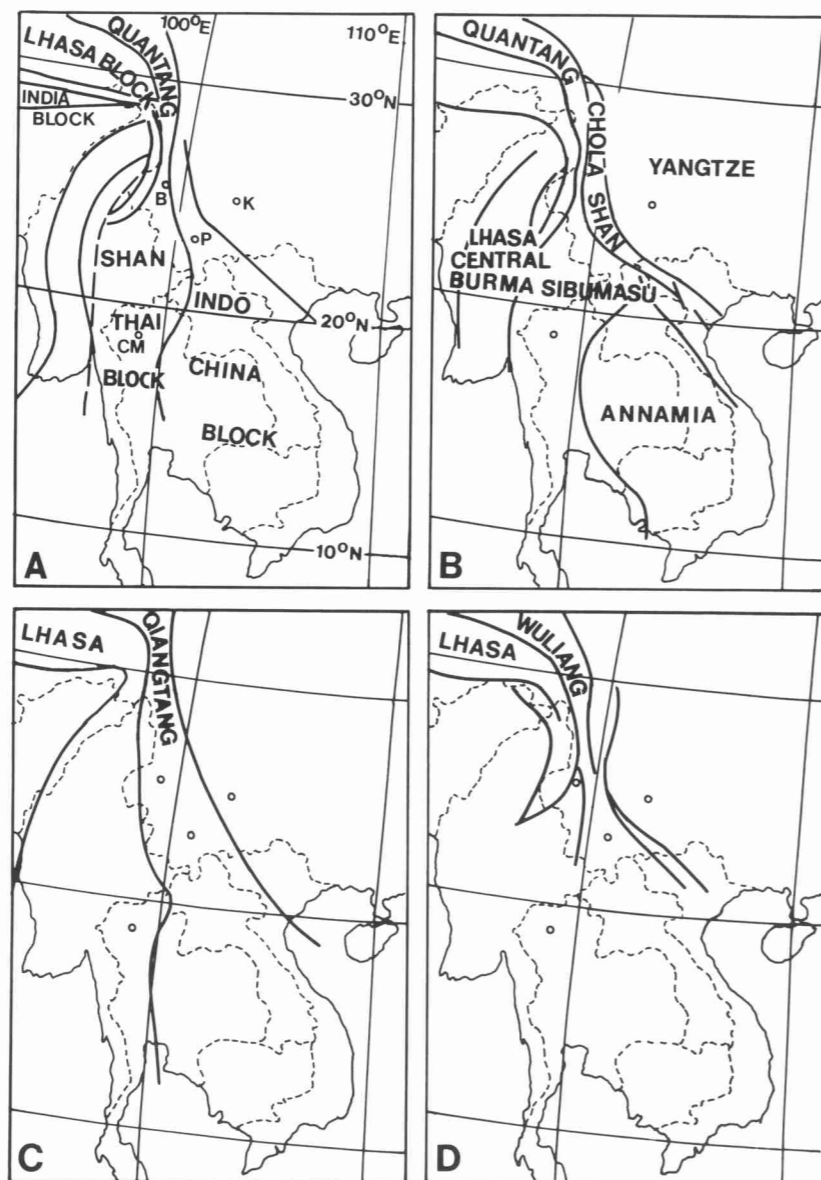


Fig. 1. A selection from the many and varied interpretations of the suture pattern (and hence terranes) in Southeast Asia. The thick lines represent the sutures identified by the various authors and in each part the tectonic elements are named as in the source publication. *B* = Baoshan; *CM* = Chiang Mai; *P* = Puer; *K* = Kunming. Sources: (A) Mitchell, 1989; (B) Şengör et al., 1988; (C) Smith, 1988; (D) Hutchison, 1989b.

blocks. No geographic barriers were recognised in his study implying the absence of separation of oceanic proportions and faunal changes were considered to be a function of latitudinal control. Also he proposed that his Cathaysian tectonic elements remained part of Gondwana until late Early Permian time. At the same time Lin and Watts (1988), employing a mixture of palaeomagnetic, geological and palaeontological data, interpreted a virtually contiguous land mass through the central Palaeo-Tethys region in the Late Carboniferous. They suggested that the northern and southern branches of Tethys may have been epicontinental seas and saw no need for oceans (see also Long and Burrett, 1989).

The recent redefinition of the paradox is still being actively debated. Like the initial conflict, many of the problems grew out of a lack of field data largely stemming from the remoteness of many of the key localities. Much of the region in question is difficult mountainous terrain where even reconnaissance mapping is incomplete. Some of the more recent data to emerge from critical regions are supporting the case for a significant Palaeo-Tethys. For example, the latest palaeomagnetic results from the Devonian and Carboniferous of western Yunnan contradict the reconstruction proposed by Lin and Watts (1988). Mutually supportive results from several groups indicate a palaeolatitude of about 40°S for the Baoshan area during Devonian–Carboniferous time (Zhang and Zhang, 1986; Fang et al., 1989; Huang and Opdyke, 1991). Baoshan (Fig. 1) is the northern part of the Sibumasu block (Metcalf, 1984) which has been variously named the Shan–Thai craton, Shan–Thai–Malay block, or Sino-burmalaya block. There is general consensus that the South China block was in equatorial regions during the late Palaeozoic, hence the two blocks were at very different latitudes.

Limitations in the field data are particularly apparent when the plethora of putative sutures and terranes is compiled from publications on the Southwest China and Southeast Asian region (Fig. 1 provides a sample from the spectrum). Many of the major terranes are identified in most analyses but boundaries are often placed in very different positions (see e.g., Şengör, 1979, 1984, 1985, 1987;

Mitchell, 1981, 1989; Metcalfe, 1984, 1988, 1990, 1993; Smith, 1988; Hutchison, 1989a,b). Minor tectonic elements are very variably treated as are possible links between major terranes around the Northwest Yunnan syntaxis. Such basic uncertainty adds to the difficulties of determining the timing of rift, drift, amalgamation, and accretion events, over which there are considerable differences of opinion (Metcalf, 1990, 1993). Clearly, palaeobiogeographic research will be severely hampered if the tectonic building blocks are not well defined. Several studies claim to have used well established tectonic lineaments to bound sample areas even though considerable tectonic complexity was present; having gathered and analysed the data within these confines, few authors took the step of questioning the validity of the tectonic subdivisions employed and how they withstood the analysis. Many reconstructions are incomplete because they do not recognise enough of the complexity of the tectonic assembly of Asia even though this picture was emerging in the early 1970s (see e.g., Burrett, 1974).

Our contribution is based on recent field work we have carried out in western Yunnan aimed at improving the definition of the tectonic elements and their histories. The results published here focus on the palaeogeographic significance of late Palaeozoic radiolarian chert sequences and oceanic basalts found along the Changning–Menglian and Jinsha zones (Fig. 2). Preliminary reports on the siliceous sequence, and the radiolarian assemblage from Menglian, were published by Wu and Li (1989), and Wu and Zhang (1989). Here we present further data on the late Palaeozoic oceanic sedimentary rocks of western Yunnan that represent evidence for a vast Palaeo-Tethys ocean which separated the Sibumasu block, a Gondwanan element, from the Cathaysian South China block (superterrane). The Changning–Menglian zone is equivalent to the suture between the Sibumasu and Indochina blocks which was identified by Hutchison (1989a,b) as the major faunal break between Gondwanan assemblages to the west and Cathaysian to the east. Himalayan overprints are particularly severe in this region which make the links between Southeast Asia and Tibet particu-

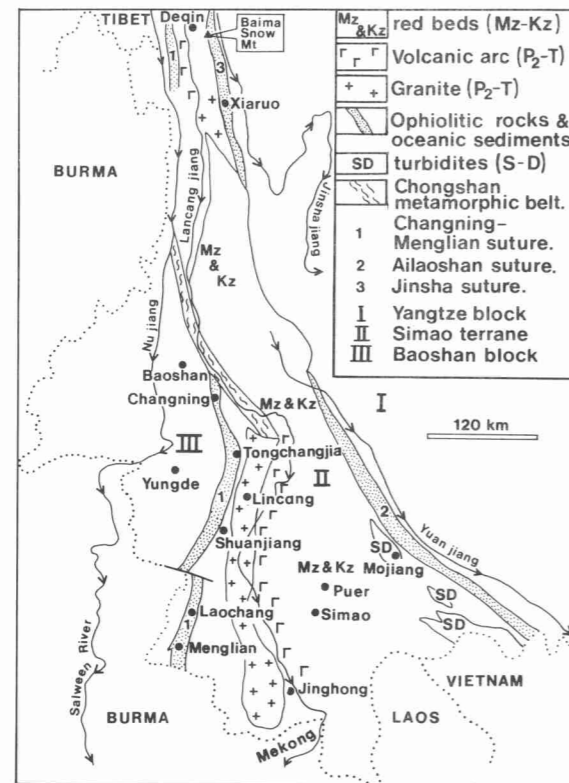


Fig. 2. A geological map of the main tectonic elements of the area of Southwest China studied for this report.

larly hard to trace. Prior to the India/Asia collision, the Cimmerian orogenic belts were trending approximately east–west. As a result of the Himalayan collision, oroclinal bending has, over large distances in the Three River Belt (Salween–Mekong–Yangtze), turned these trends through 90°. Considerable contractional and strike-slip deformation of Himalayan age have deformed the earlier sutures and terranes creating a region of considerable complexity. The kinematics of this zone are important in the debate concerning the mechanism of India's indentation into Asia. In the view of Tapponnier et al. (1986) this was largely achieved by extrusion of eastern Asia, whereas Dewey et al. (1988) see no need for significant extrusion and considered the orocline to have been created by a right-lateral shear zone along the eastern edge of the indenter.

2. Changning–Menglian suture zone

The tectonic significance of the Changning–Menglian suture zone (Fig. 2) was first recognised by Huang et al. (1984) who named it the Changning–Shuangjiang suture. They interpreted the zone as representing a pre-Permian ocean that separated the Baoshan–Shan State block (Sibumasu terrane) from the terranes to the east. Huang et al. (1984) regarded the suture as a branch of the Jinsha–Tengliao River suture. This latter suture, normally referred to in the English literature as the Jinsha suture, forms the eastern and northern boundary of the Qiangtang block (referred to as the Yunling–Wu Liangshan terrane by Huang et al., 1984). Unfortunately, Huang et al. (1984) provided very little descriptive information about the nature of the suture. In 1985, Zhang et al. applied the name Changning–Menglian ophiolite belt to the Changning–Shuangjiang suture and described an ophiolite melange in the northern part of the belt. In this publication we prefer the name Changning–Menglian suture, first used by Wu and Zhang (1989), because Menglian is close to the southern end of the suture as mapped within Chinese territory. In addition, the Menglian area contains well developed sequences of ophiolitic basalts and radiolarian cherts.

The Changning–Menglian suture, marked by dismembered ophiolites and associated deep-water sedimentary rocks, can be traced from Menglian northwards through Laochang, Tongchangia to Changning (Fig. 2), a distance of more than 400 km. It is interrupted to the north by the Chongshan metamorphic belt which also cuts the northern margin of the Baoshan block. Southward, the suture probably extends through Burma into northern Thailand. The most complete descriptions of the ophiolitic melange and ophiolitic basalts are from Tongchangia in Yun County, and the Menglian district (Zhang et al., 1985; Li et al., 1986). The ophiolitic melange (Zhang et al., 1985) is composed of blocks of harzburgite, cumulate websterite, gabbro, basalt, limestone, and chert, set in a mud–silt grade matrix. The basalts include two types distinguished on the basis of their geochemistry. One is characterised

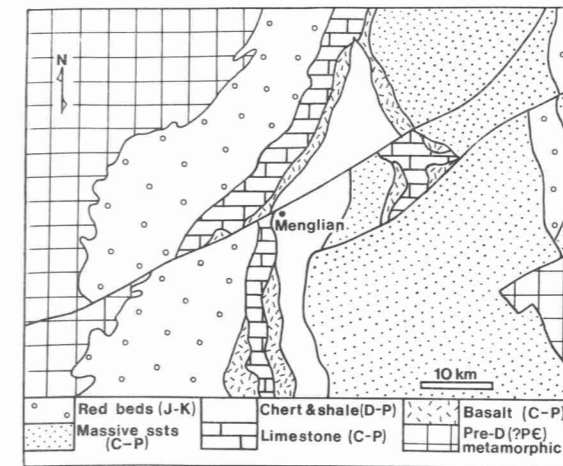


Fig. 3. An outline geological map of the Menglian district showing the extent of suture zone features at the southern end of the Changning–Menglian belt just inside Chinese territory.

by high-Fe and low-Mg which, taken with REE data, indicate that they are similar to mid-ocean ridge basalts. The other basalt type has high-Ti and REE patterns similar to ocean island basalts. Deng (1987) noted more than 100 small ultramafic and mafic bodies distributed along the Changning–Menglian zone but did not provide information on the nature of their contact relations with the country rocks.

Within the narrow Changning–Menglian belt (Fig. 2) there is a complexly deformed oceanic sedimentary sequence associated with the ophiolitic rocks. In the Menglian district (Fig. 3), which is so remote that geological work only commenced there in 1980, the zone of oceanic sedimentary rocks is well developed with widths varying between 4 and 10 km. The zone consists mainly of dark green and dark grey cherts with minor black chert, siliceous shales, and silty shales. The original stratigraphic sequence is very difficult to reconstruct for a variety of reasons. In this tropical region, exposure is generally very poor, with the shales being particularly badly affected by deep weathering. Tectonism complicates the internal geometry of the siliceous sequence; the bedded cherts are tightly folded and

affected by contractional faults. Also fossils are sparse.

The earliest fossil-bearing strata found so far in the belt are Early Devonian. Early Devonian graptolites (e.g., *Monograptus microdon* Richter, *M. aequabilis* (Pribyl) and *Neomonograptus cf. hercynicus*, Jackson and Lang) occur in dark shales intercalated with bedded cherts to the south of Menglian (Duan et al., 1982). In the northern part of the suture zone, immediately south of Changning, Qin et al. (1980) recovered the Early Devonian fossils *Neomonograptus himalayaensis* Mu and Ni, and *Nowakia acuararia* (Richter). Because the Late Devonian conodonts *Palmatodella delicatula* Virich and Bassler, *Palmatolepis* sp. and *Ozarthodina homoaronata* Helms were also found in an alternating chert and siliceous mudstone to the south of Menglian, the local survey inferred the whole siliceous sequence to be Devonian (Duan et al., 1982). Subsequently, Wu and Li (1989) reported Carboniferous and Permian radiolarian fossils from the siliceous sequence from several localities along the highway to the south of Menglian. The Early Carboniferous radiolarians *Archocyrtium menglianense* Wu, *A. cf. wonae* Cheng, *Deflandrellium* sp., and *Albaillella* sp., were found from near the 37 km marker. The Early Permian radiolarians *Pseudoalbaillella U-forma* Holdsworth and Jones, and *P. longicornis* Ishiga and Imoto, and others, were found near the 29 km marker. The middle Permian (late Guadalupian) radiolarian assemblage consisting of *Follicucullus* sp., *Albaillella excelsa* Ishiga, Kito and Imoto, *A. levis* Ishiga, Kito, and Imoto, and *A. triangularia* Ishiga, Kito, and Imoto, was found near the 30 km marker and at many localities between the 43 and 48 km markers. Therefore, the age of the siliceous sequence, based on the fossil evidence, ranges from Early Devonian to middle Permian, though younger rocks are probably present.

The siliceous sequence, which is in fault-contact with the basalts, has an outcrop width normally ranging between 4 and 10 km. Because of severe weathering the basalts are mostly covered with thick red soils, but fresh pillow lava exposures can be seen in riverbanks and in a new road cut near Manxin village, 20 km south of Menglian.

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