The Triassic of China

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Translator's Note

The majority of place names and fossil localities are listed under the Pinyin romanization system. For the Tibetan Plateau and Xinjiang Autonomous Region, place names are derived from "Map of the People's Republic of China" (1984), Cartographic Publishing House, China, and Esselte Map Service AB, Sweden. This may create some confusion to readers familiar with the older literature as the majority of Triassic research in China was published in English under the Wade-Giles romanization system prior to the establishment of the People's Republic by workers incluing Amadeus Grabau, Eric Norin, V.K. Ting, C.C. Young and others. In order to alleviate confusion, two appendices are provided at the end of the text that correlate Wade-Giles to Pinyin romanization and vice versa.

Abstract

Ten years after the establishment of the People's Republic, Liu et al. (1962) summarized research upon the Triassic of China. Subsequent investigations into the Triassic of China have (1) strengthened regional Triassic mapping and reconnaissance, (2) established preliminary regional Triassic biostratigraphic subdivisions to erect a larger regional or national chronostratigraphic complex by utilizing data including ammonites and the benthic faunas (bivalves and brachiopods), (3) obtained definitive results in boundary stratigraphy, particularly in Permo-Triassic boundary studies, (4) coordinated mineral surveys with natural resource exploration, such as petroleum, evaporites, and metals, to facilitate recognition of regional Triassic lithofacies paleogeography, carbonate research, and studies on reef faunas, and (5) advanced isotopic dating, paleomagnetic stratigraphy, and petrology to further the study and exploration of Triassic paleoenvironments. Results from these endeavors form a large Triassic database which constitute a solid foundation for further research.

Triassic Distribution, Development, and Regional Subdivision

1. Chinese Triassic Stratigraphic Subregions

(see Table 1 and Figure 1)

Triassic paleogeographic history of China occurs subsequent to the Variscian tectonic movement when North China formed into the paleo-Asian continent Cathashia. East China, however, continued its evolutionary trend inherited from the Paleozoic, or more precisely the terminal Silurian, by remaining as a stable platform. Western China was situated between the eastern China-Tarim Basin regions and the Gondwanan terrane to develop later into a complex geosynclinal trough. Within this structural pattern, and during the Permian to Jurassic Indosinian Orogeny, Chinese Triassic sedimentation developed with distinct regional characters: marine sediments exist south of the paleo-Kunlun paleo-Qingling mountain ranges, while north of this lineament sedimentation is terrestrial. East of the Longmenshan Mountains-Honghe River, China constituted a platform, while west of this boundary there developed geosynclinal topography. These three continental, platform, and geosynclinal facies models reflect Chinese Triassic sedimentation. Their paleogeographic margins are all bounded by deep sutures* or reactivated rift systems. More specifically they are designated the Kunlun-Qinling suture and the Longmen-Honghe suture.

Note: A portion of this paper quotes text from *The Stratigraphy of China-Triassic System* (in press) edited by the Chinese Academy of Geology. (Translators addendum: Publication of this volume has been indefinitely suspended.)

* The translator prefers the term "suture" rather than the more literal translation "rift," for although the referred features display basin and range type spreading activity, they are not "rift zones" sensu stricto, but are actually exotic terrane boundaries.

Huang (1959) and Wang (1978) recognized ten Chinese Triassic stratigraphic provinces based upon paleostructural patterns, paleogeographic outline, depositional models and complexes, bioprovinces, and biofacies, as summarized below.

I. Northern Xinjiang-Beishan Mountains Region.

This region encompasses the areas west of the Beishan Mts. in Gansu Province and North of the central Tianshan Mts. deep suture in northern Xinjiang Autonomous Region. The region constitutes a series of intermontane grabens and fluviolacustrine basins, including the Junggar, Turpan, and Yining basins. Triassic sediments in each of the basins are represented by 500 to 2,000 m of purple-red and gray-green sands, shales, and sandy conglomerates that produce the *Lystrosaurus-Sinokannemeyeria* fauna including *Lystrosaurus*, *Chasmatosaurus*, and *Prolaceratoides* in addition to a Yanchang Flora which is characterized by *Danaeopsis* and *Bernoullia*. The regional type-section lies in the Junggar Basin where the Triassic is represented by the Upper Cangfanggou Group (T_1c) and the Xiaoquangou Group ($T_{2+3}x$).

II. Southern Tianshan Mts.-Tarim Basin Region

The Tarim Platform is the principal body of this region that is bordered to the north by the central Tianshan upwarp, and to the south by the Kunlun and Altuntag sutures. Triassic sedimentation is well developed in several small-scale intermontane basins and foredeeps and is characteristically similar to the Northern Xinjiang-Beishan region. Frequently, the sections are incomplete by lacking the lower, middle, or upper members of the system. Fauna in the Middle Triassic is represented by the conchostracan *Diaplexa* and fresh-water bivalves. The Upper Triassic contains a mixed flora with the northern *Thinnfeldia-Danaeopsis fecunda* complex and the southern *Ptilozamites-Lepidopteris* complex. A regional type-section is represented by the Ehuobulake Group (T_1e) and the Xiaoquangou Group in the Kuqa subbasin.

III. North and Northeast China Region

This region is bordered to the south by the Qinling suture. To the north it extends into the central Mongolian and Siberian frontiers, and to the east is bordered by Triassic geosynclinal facies in the Nadan Hada Range. The area encompasses eleven provinces and autonomous regions in North China. Lithologies are dominated by large-scale innercontinental fluviolacustrine basin sedimentation such as the Shaanxi, Gansu, Ningxia Basin (henceforth referred to as the Shaanganning Basin) and the Qinshui Basin. Secondary occurrences of small intermontane subbasins and marine flood basin sedimentation are present. The former is represented by the Liujiagou, and Shanggou Formations, and the Yanchang Group, while the latter is represented by the Xidagou Group and Dingjiayao and Nanyinger Formations in the Shaanganning Basin. A climatic shift from xeric to mesic temperate occurs from the Early Triassic to the early Middle Triassic as represented by the well-developed *Pleuromeia* and *Voltzia-Aipteris wuziwanensis* floras. The Late Triassic also reflects a mesic temperate climate, evidenced by the presence of the well-known Yanchang floras and faunas (including the *Annalepis-Tongchuanophyllum* complex, the *Danaeopsis-Bernoullia* complex, and the *Shaanxinoconcha-Unio* freshwater bivalve complex). Stratigraphic thicknesses range from 1,500 to 4,500 meters. A representative cross-section is recognized in the Shaanganning Basin.

IV. Kunlun-Qinling Region

To the north, this region is bordered by the Altuntag, Qilian, and Qinling sutures, and to the south by the Jinshajiang-Honghe suture. Geographically, it encompasses a portion of southern Xinjiang and portions of northern Tibet, Qinghai, southwest Gansu, western Sichuan, and northern Hubei. The region contains relatively complete Triassic sections with the exception of the

southern Qilian and western Qinling regions, which lack sediments equivalent to the European Ladinian Stage in addition to Upper Triassic. A majority of this region (including the Bayan Kalashan Mts. and western Qinling Mts.) reflects miogeosynclinal sedimentation, but a portion of the region (Nanshan Mts., Qinghai, and the Yidun-Zhongdian region) contains eugeosynclinal sedimentation. Furthermore, platform sedimentation is observed in the Burhan Budai and Songpan regions. Sedimentary complexes are predominantly sandy or argillaceous flysch and argillo-calcareous flysch with secondary occurrences of pyroclastic flysch and melange. The top of the sequence is represented by an alternating complex of marine to continental facies with carbonaceous sediments. The entire Triassic sequence here is massive, with regional thicknesses that may reach 20,000 m. Type sections are represented by the Bayankala Group ($T_{1-3}by$) and Longwuhe Group (T_1lw).

Faunas in this region are dominated by pelagic ammonites and bivalves. Sessile benthic bivalves, brachiopods, and reef faunas are only observed regionally and in a few stratigraphic horizons. Brachiopod faunas are restricted to the regional Tethys system. Several regions, such as the Lake Tosonhu region, however, produce taxa characteristic of the northern regional systems (discussed later in the text). Particularly characteristic of this region are Anisian Stage ammonite faunas which include (1) the *Lenotropites-Paracrochordiceras-Japonites* horizon, (2) the *Anangymnotoceras* horizon, and (3) the *Pseudaploceras-Semiornites* horizon.

V. The Tibet-Western Yunnan Region

This region is bordered to the north by the Kunlun-Qinling region (IV) and to the south by the Yarlungzangbo suture, to include a large portion of the Tibetan Autonomous Region, and southern portions of Qinghai and Sichuan, in addition to western Yunnan Province.

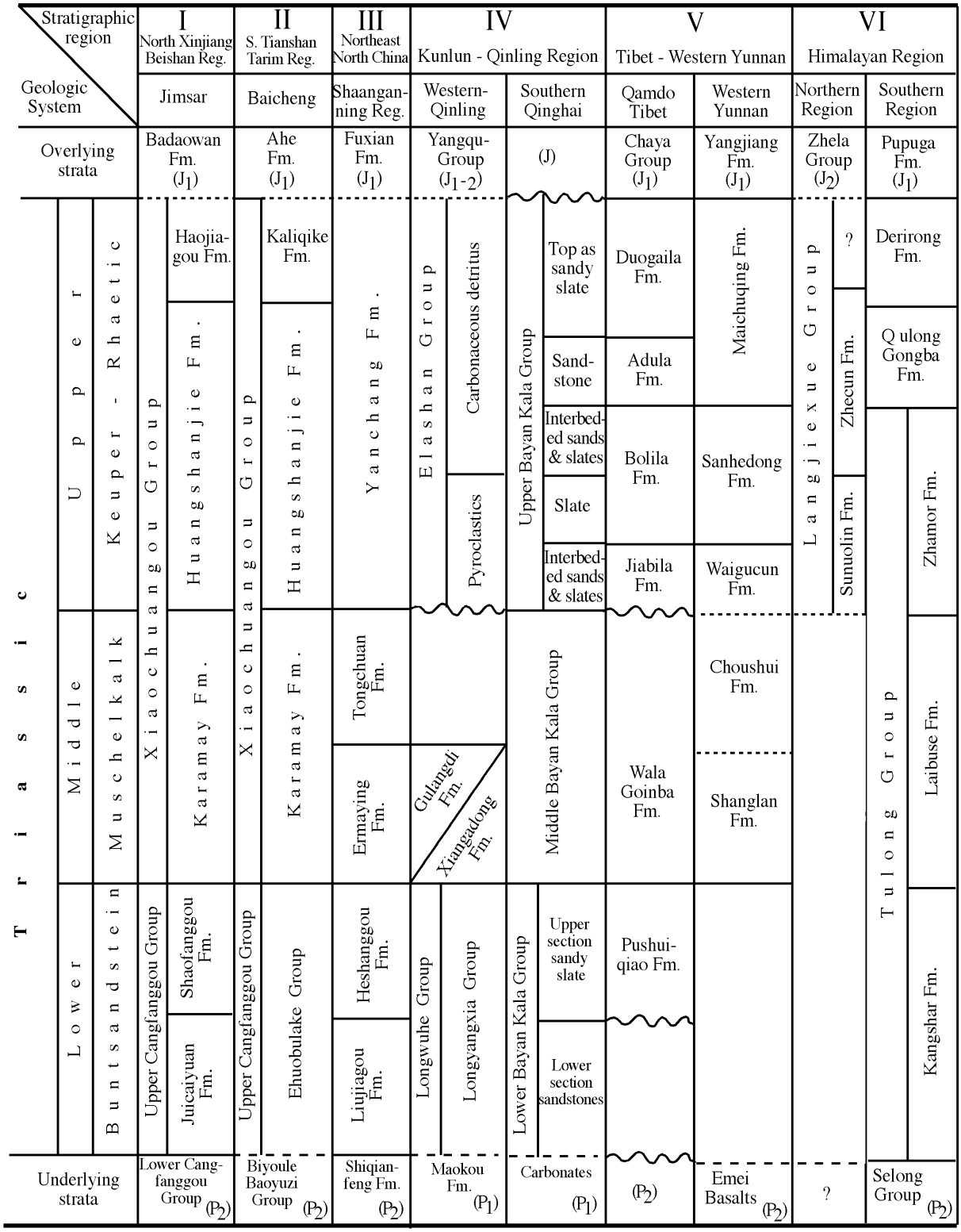
The well-developed Triassic system here occurs in several structurally distinct styles and contrasting sedimentary regimes: The northeast Three River Fold System is a eugeosynclinal belt characterized by moderately silicic to moderately mafic pyroclastics, flysch, and ophiolitic melange. The southwestern Danglashan (Tanggula) Mts. and western Yunnan region represents a large intermediate massif with sedimentary complexes composed of purple-red detritus, carbonates, and carbonaceous deposits that reflect shallow marine platform to interbedded marine and terrestrial facies. A large region south of the Bangonghu-Nujiang suture represents the Gandise-Chayu terrane. Sediments such as radiolarian cherts are noted only in the vicinity of the Yarlungzangbo suture near Lahsa. Thicknesses of the Triassic here range between 4,000 and 10,000 meters. Faunas are Tethyan in nature and resemble those in the Yangzi region (VII). The Upper Triassic in the western Yunnan and Qamdo region is relatively well developed and may be regarded as a representative cross-section for the region.

VI. Himalayan Region

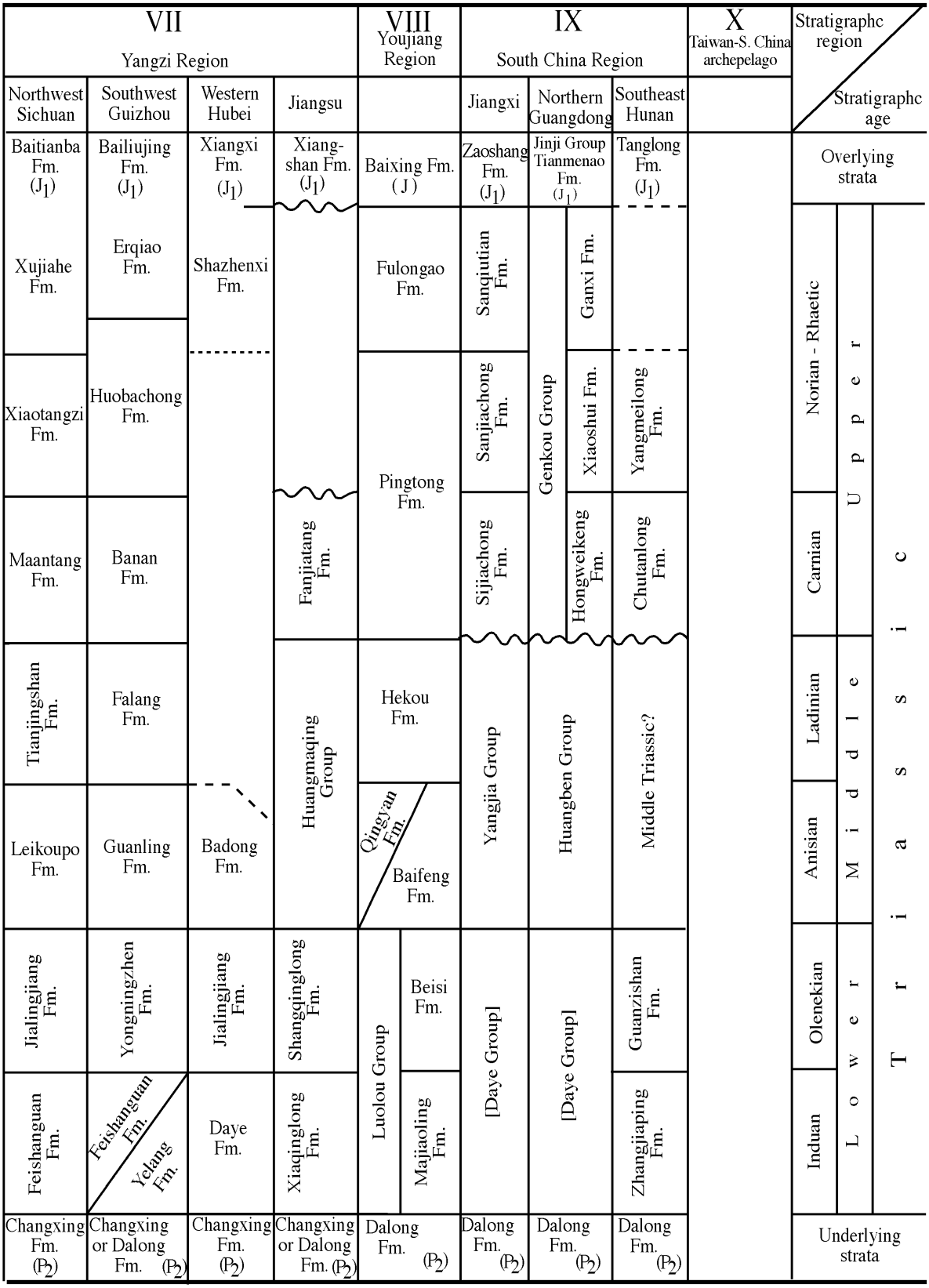
To the south this region encompasses the vicinity of Mt. Everest (Qomolangma) and to the north includes the Yarlungzangbo (upper Bramaputra) River. The Everest vicinity represents a portion of the Gondwanan supercontinent and contains nearly 1,500 m of Lower, Middle, and Upper Triassic platform sediments composed of shallow marine mixed clastic carbonates. Detailed studies recognize eight ammonite horizons, at the base of which lies the Lower Triassic *Otoceras latilobatum* Zone. In the Yarlungzangbo region, only the Upper Triassic is documented, composed of over 10,000 m of geosynclinal deposits consisting of sandy slate grading to radiolarian silicates and moderately mafic pyroclastics. Faunas include the pelagic bivalves *Halobia* and *Monotis,* in addition to ammonites.

A representative section is recognized in the celebrated Mt. Everest region which comprises the Tulong Group, the Qulonggongba Fm, and the Derong Fm..

Table 1. Triassic of



China correlation chart



VII. Yangzi Region

In a general sense, this region is synonymous with the Yangzi Paraplatform. To the north it is bounded by the Chengkoufanxian-Xianshuijiashan sutures, while to the northeast it is bordered by the North China Region (III) and the Kunlun-Qinling Region (IV). To the southeast the border is provisionally recognized at the Pingtang-Kaiyuan suture, the South China Region (IX), and the Youjiang River Region (VIII). This encompasses the provinces and regions of the Yangzi (Changjiang) River Valley.

The Triassic of the Yangzi region, together with Upper Precambrian and Paleozoic rocks, represent the sediments overlying the Yangzi Platform. The Lower and Middle Triassic consist of marine terrigenous-lagoonal deposits, while the Upper Triassic consists of a complex of estuarine and intercalated marine continental facies, carbonaceous paludal deposits, and alluvial sediments. Here, influence from the Xinjiang-Yunnan terrane and regional northeast rifting and deformation allow recognition of regional facies subdivision. For instance, the Lower Triassic along the 107°-108° longitudes are recognized as the Feixianguan facies (clastics), Daye facies (carbonates), and Yelang facies (mixed carbonate clastics). The Middle Triassic is recognized as the Badong facies (littoral), Leikoupo facies (carbonates), and Huangmaqing facies (deltaic). Total thickness ranges between 1,000-7,000 meters, and is thickest in the area's border regions (that is, the border depression areas of the Yangzi Platform such as the Longmenshan Foredeep). The Triassic is conformable with the underlying Permian and overlying Jurassic sediments, but in several regions there are disconformities.

Triassic faunas in the Yangzi Region are Tethyan and predominantly sessile benthic, although in several regions, formations, and rock members, there are relatively abundant pelagic forms present. Floras are southern in nature, including the *Annalepis-Neocalamits meriani* complex and the *Ptilozamites-Lepidopteris* complex. Ammonite and bivalve faunas are the most significant toward regional subdivision: the Lower Triassic is recognized by the *Claraia* and *Eumorphotis* assemblage, while the *Tirolites cassianus* and *Progonoceratites* ammonite zones are distinct marker beds for the lower Middle Triassic in South China (discussed in more detail later in the text).

VIII. The Youjiang River Region

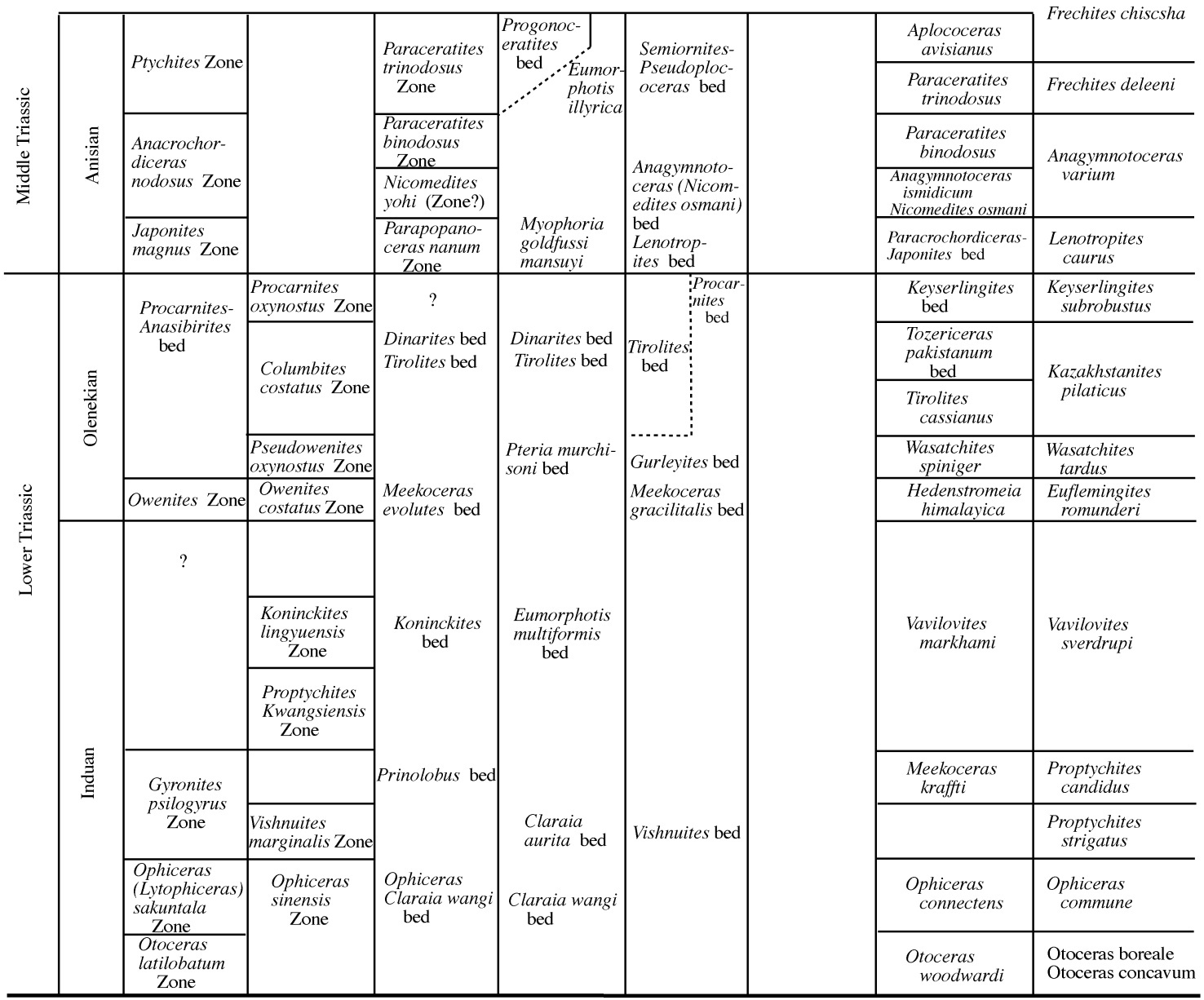
This region is bordered to the northwest by the Yangzi Region (VII) and to the southeast by the western borders of the Jiangnan and Yunkai terranes to include the geographic regions of southern Guizhou, a portion of southeast Yunnan, and a large portion of Guangxi province. This encompasses a relatively small and narrow vicinity, but Triassic sediments are particularly characteristic in nature, as they consist of reactivated geosynclinal deposits.

In this region the Lower and Middle Triassic are predominant, with the Upper Triassic noted only in the Shiwandashan Mts. region. The Lower Triassic consists of ash flow turbidites which is in contrast to the shallow marine continental shelf carbonate complexes in other neighboring regions. The Middle Triassic of this region consists universally of terrestrial clastic turbidites, while the Upper Triassic consists of mountain foreland red molasse and interbedded carbonaceous marine and terrestrial facies. Moderately silicic pyroclastics occur in all three stages, although occasionally moderately mafic lavas, spilite, and melange are noted. Thicknesses vary from 5,000 to14,000 m. An unconformable contact lies between the Middle and Upper Triassic, although the Permo-Triassic and Triassic-Jurassic contacts are for the most part conformable.

Triassic faunas in the Youjiang region are dominated by Tethyan pelagic taxa. In the Late Triassic this fauna becomes very similar to the provincial Burmese Naben Fauna to compose a

Table 2. Stratigraphic correlation chart of the Chinese marine Triassic

Stage \ Area		Mt. Everest (Qomolongma)	Guangxi	S. Guizhou	Sichuan	Qinghai	N. Guangdong	Tethys**	N. America*
Upper Triassic	Rhaetian	?						*Rhabdoceras suessi*	*Choristoceras marshi* *Rhabdoceras suessi*
	Norian	*Himavatites columbianus*					*Modiolus-Jiangxiella* bed	*Himavatites columbianus*	*Himavatites columbianus*
		Cyrtopleurites socius Zone						*Cyrtopleurites bicrenatus*	*Drepanites rutherfordi*
		Indojuvavites angulatus Zone				*Steanarcestes leiostracus* bed	*Palaeopharus-Oxytoma* bed	*Juvavites magnus*	*Juvavites magnus*
		Griesbachites-Gonionotites Zone						*Malayites punlckei*	*Malayites dawsoni*
		Nodotibetites nodosus Zone						*Guemberites jandianus*	*Mojsisovicsites kerri*
	Carnian	*Parahauerites acutus* Zone			*Thisbites-Discotropites* bed	*Discotropites qinghaiensis* bed	*Bakevelloides-Cuneigervillia* bed	*Anatropites*	*Klamathites macrolobatus*
		Hoptotropites Zone						*Tropites subbullatus*	*Tropites welleri*
		Indonesites dieneri bed						*Tropites dilleri*	*Tropites dilleri*
					Trachyeras-Protachyceras bed	*Trachyceras aon* bed		*Trachyceras austriacum*	*Sirenites nanseni*
								Trachyceras aonoides	*Trachyceras obesum*
Middle Triassic	Ladinian	*Protrachyceras-Joannites* bed		*Protrachyceras deprati* bed		*Protrachyceras-Paratrachyceras* bed?		*Protrachyceras archelaus*	*Frankites sutherlandi* *Maclearnoceras maclearni* *Meginoceras meginae* *Protrachyceras poseidon* *Protrachyceras archelaus*
				Protrachyceras prinum Zone				*Protrachyceras reitzi*	*Frechites chiscsha*
	Anisian	*Ptychites* Zone		*Paraceratites rinodosus* Zone	*Progono-ceratites* bed / *Eumor-photis illyrica*	*Semiornites-Pseudoploc-oceras* bed		*Aplococeras avisianus*	
								Paraceratites trinodosus	*Frechites deleeni*



* After E.T. Tozer, 1978, 1973; **After R. Assereto 1973 and H. Zapfe 1973.

small bioprovince. Nine ammonite zones are recognized in the western Guangxi region, which is a subregion of the Luoluo Group, and representative for the Lower Triassic of the entire country. The Qingyan Fm. (T_2q) in Guizhou contains four ammonite zones that are a relatively good represention of the Anisian Stage in China.

IX. The South China Region

To the northwest, this region is bounded by the Yangzi and Youjiang regions to encompass the southeast China provinces of Fujian, Guangdong, eastern Guangxi, Jiangxi, Hunan, and Zhejiang. More interestingly, this stratigraphic regime is also recognized in the mountain ranges (Nadan Hada Ling) of northeast Manchurian China, northeast Jilin, and eastern Heilongjiang provinces.

The Lower Triassic of this region is extensively distributed, while the Middle Triassic is absent throughout much of the region, and the Upper Triassic is sporadically represented. Lower and Middle Triassic sediments are dominated by littoral clastics, as noted in the Xikou, Xiwei, and Anren Fms. of southern Fujian Province. A portion of the region's Lower Triassic consists of carbonate complexes as represented by the Daye Group in Hunan and Jiangxi provinces. The Upper Triassic consists of a complex of interbedded carbonaceous clastics representing interbedded intermontane, innercontinental lacustrine, and marine and continental facies. These are noted in the Genkou Group in northern Guangdong and southern Hunan, and the Anyuan Group in eastern Hunan and western Jiangxi. In the Nadan Hadaling Range of eastern Heilongjiang Province, the Upper Triassic constitutes geosynclinal facies or pyroclastic flysch. Sedimentary thicknesses generally range from 800 to3500 m. A distinct unconformity lies between the Middle and Upper stages, but between the Permian and Jurassic both conformable and disconformable contacts are noted.

Late Triassic faunas represent a regional Pacific system with the *Tosapecten-Palaeopharus* complex that correlates to southern Japan and Siberia. The *Neuropteridium-Coltzia* flora in the south (on Hainan Island) and the *Ptilozamites-Lepidopteris* flora (including localities such as Anyuan, Jiangxi Province) are significant regional indicators.

X. Taiwan and South China Archipelago

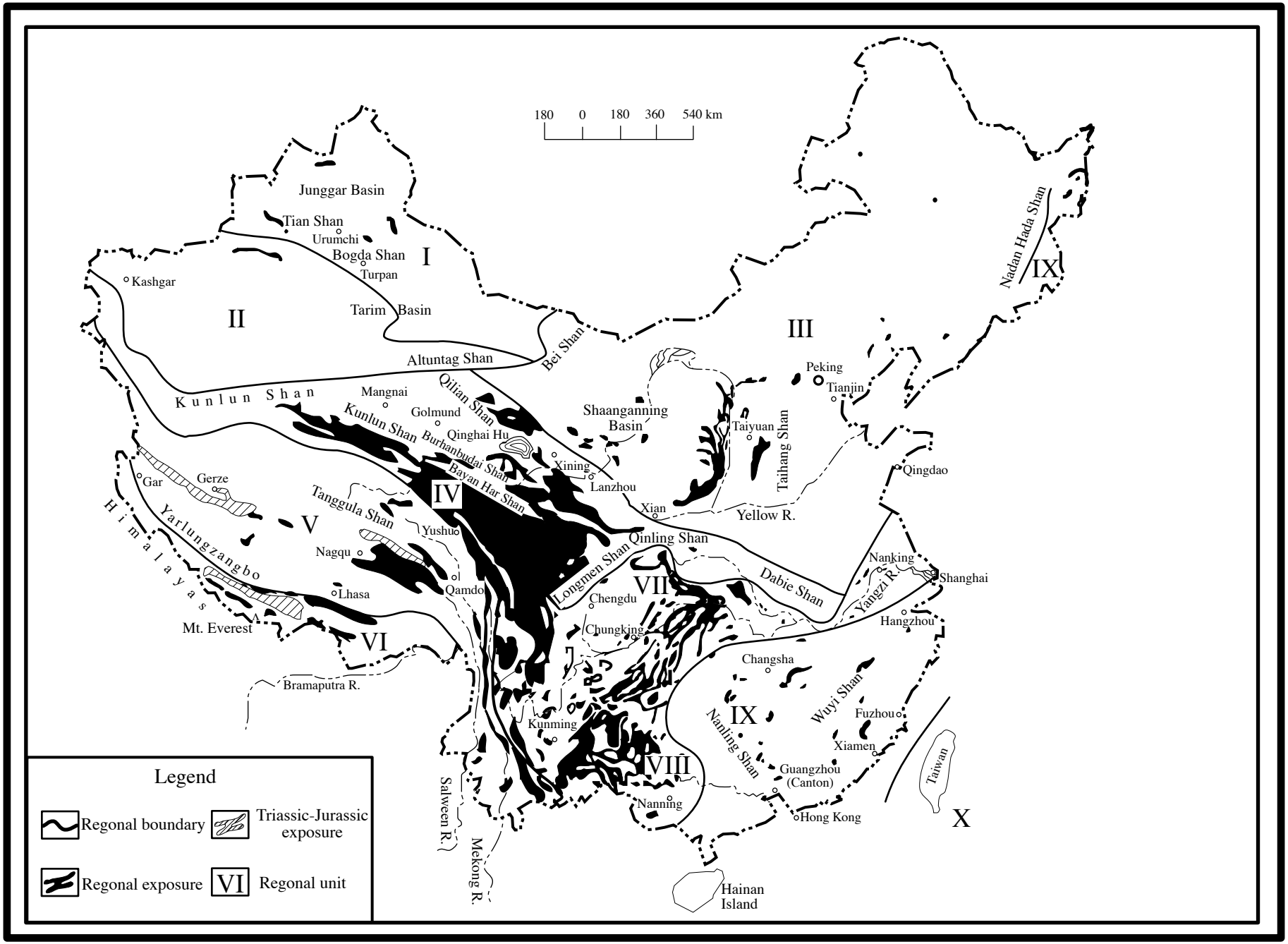
To date, no Triassic is recognized in this region.

2. Triassic Distribution and Patterns of Development

Depositional Models and Distribution of Triassic Continental Facies in North China

Paleogeographic and structural influences have controlled North China's Triassic sedimentation, creating rather distinctive regional sediments. Running directly eastward from the northwest paleo-Tianshan mountain region to the paleo-Qilian, and paleo-Qinling Mountains, there is a linear distribution of intermontane basins, such as the Yining and Minhe basins, that contain complexes of coarse clastics or molasse. In general the stratigraphic sequence is incomplete but sedimentation is rapid, reflecting relatively strong tectonic activity. Continuing on this lineament eastward, moderately silicic to silicic terrestrial lava flows appear in the Zhouzhi and Shangxian basins in Shaanxi Province. Coarse clastics and igneous rocks reflect orogenic activity within a complex of linearly distributed intermontane basins around the continental margin. Further to the northeast on the North China Qiuling Plain, the Shaanganning and Qinshui basins contain innercontinental fluviolacustrine complexes of fine clastics, which suggest depositional stability.

Figure 1. Triassic Stratigraphic Regions of China.



The aforementioned depositional characters also reflect distinct biogeographic provinces. A northern floral province lies in the northwest mountain regions north of the Tianshan-Qinling Lineament which contains a Yanchang Flora represented by an *Annalepis-Tongchuanophyllum* complex, the *Danaeopsis-Bernoullia* complex, and the *Pleuromeia-Votzia* flora. A southern floral province lies south of this lineament in the southern Tianshan Mts., the southern Qilian Mts., and the western Qinling Mts., which contains a *Ptilozamites-Lepidopteris* complex and an *Annalepis-Neocalamites meriani* complex. Several localities within the vicinity of the lineament boundary contain a composite northern and southern flora in association with distinct endemic characteristics. These boundary floras reflect a hot xeric to temperate mesic climate, as opposed to a southern tropical climate.

Marine Lithofacies and Regional Characteristics of the Yangzi Region

The Yangzi Triassic system consists of a widespread and persistant facies. East of the Xinjiang-Yunnan terrane, the laterally persistent Lower Triassic is recognized as the Feixianguan, Yelang, and Daye facies. The Yelang and Daye facies are restricted to 107°-108° longitude. A Middle Triassic facies change occurs in contrast to Lower Triassic sedimentation and becomes recognized westward as the Huangmaqing, Badong, and Leikoupo facies. These depositional zones were influenced by secondary tectonic activity of the Yangzi Platform in addition to regional denudation. Secondary tectonic activity consisted of the downwarping of the Longmenshan Mt. border, orogeny of northern Guizhou-central Sichuan, and downwarping of eastern Sichuan-western Hubei in addition to the margins of southwestern Guizhou-southeastern Yunnan. The margins of these tectonic subregions frequently display contemporaneous faulting and formation of zonational boundaries, as exemplified by the fault zones bounding both sides of the central Sichuan-northern Guizhou orogeny.

The Yangzi subregions are predominantly based upon lithofacies zonation. Appropriately, biofacies fluctuate with lithofacies, as noted in the western Yangzi Feixianguan facies, which contain a benthic fauna with the bivalve *Claraia wangi* and *Unionites fassaensis*, while to the east, the Daye facies contains the pelagic *Ophiceras-Tirolites* ammonite fauna. The Middle Triassic western Leikoupo facies contains the open marine *Progonoceratites* ammonite fauna, as opposed to the eastern Huangmaqing facies which produces a littoral marine *Bakevellia*, *Mytilus*, and *Stellatochara* fauna.

In the Ladinian Stage, reactivated Indosinian movement affected the entire Yangzi Paraplatform to create the Luzhou-Kaijiang denudation region and compress large landmasses. Marine regression occurred in western geosynclinal regions. Ladinian-Carnian estuarine carbonate sedimentation occurred only around the downwarped regions of the Yangzi Paraplatform, such as in the Longmenshan foredeep.

Influence of Later Indosinian Activity upon South China Stratigraphic Regions

South China Early and Middle Triassic depositional regions lay principally around the Cathaysian and Yunkai terrane margins, where Indosinian activity had a profound influence upon structural and depositional patterns. Firstly, there occurred complete regional deformation of the Upper Paleozoic, Lower, and Middle Triassic platform sediments. Overlying this new structure there was deposited over 2,000 m of Cathaysian molasse, designated the Anyuan Group, which was deposited as Pacific littoral transgression encroached upon central and southeast Hunan, northern Jiangxi, and northern Guangdong provinces. The Anyuan and Langkou Groups represent basal marine transgressions and contain early Late Triassic *Bakevelloides, Tosapecten*, and *Palaeopharus*. Only upper Late Triassic continental intermontane or innercontinental sediments with thicknesses of several tens of meters to 200 m overlie the Yunkai and Cathaysian terranes

themselves, which in western Hunan is represented by the Xiaojiangkou Group, and in western Zhejiang by the Wuzao Fm.

The Development of Western China's Geosynclinal System and Deep Sutures.

Western China is recognized as those regions west of the Longmenshan suture and the Jinshajiang-Honghe suture where a complex Triassic geosynclinal system is recognized. Deep structural movements had a significant impact upon the formation and development of the Western China geosynclinal system. Six deep suture zones are recognized: the Lake Qinghaihu-northern Huaiyang zone, the Eastern Kunlun-Maqin zone, the Lueyang zone, the Ganzi-Litang zone, the Jinshajiang-Honghe zone, the Lake Bangonghu-Nujiang (Salween) River zone, and the Yarlungzangbo (upper Bramaputra) River zone.

Deep sutures are recognized in three configurations that affect the distribution and dynamics of the Western China Triassic geosynclinal system:

(1) Suture zones are aligned systematically from north to south as sedimentary facies zones. These include the Lake Qinghaihu-northern Huaiyang and eastern Kulun-Maqin deep suture zones in the western Qinling region, the southern Qinghai Mts. eugeosyncline, the western Qinling Range miogeosyncline, and the narrow Burhan Budai Platform.

(2) Western regional geosynclines occurred diachronously, with dissimilarities intimately related to the suture zones. For instance, activity in the western Qinling synclines occurred in the Early and early Middle Triassic, but subsided in the late Middle Triassic. To the southwest, the Bayan Har geosynclinal zone had been active from the Silurian to Early Triassic but only in the transitional morphology of a synclinal trough. Only in the Middle and Late Triassic was there intense geosynclinal development with its envelopment during the late Indosinian. The three rivers region, the Nujiang, Lancangjiang, and Jinshajiang (Salween, Mekong, and Yangzi) rivers concluded Late Triassic diastrophism with the deposition of the Jiapila, Bolila, Adula, and Duogaila Fms.

(3) Deep suture zones are frequently bioprovince and biofacies boundary lines, as exemplified at the Ganzi-Litang suture where both deep marine siliceous facies and shallow water reef faunas occur on each side of the lineament. Recent ammonite faunal studies indicate that north of the eastern Kunlun-Maqin and Lueyang sutures most regions contain Triassic faunas including *Vishnuites* cf. *decipiens, Denedinites, Svalbardiceras, Arctohungarites, Lenotropites,* and *Gymnotoceras,* while south of these lineaments a northern Tethys fauna including *Ophiceras, Flemingites,* and *Procarnites* is present. This indicates that the sutures are either a significant biogeographic boundary or bioprovince boundary line.

The Northern Gondwanan Himalayan Depositional Region

Increasing paleontological and stratigraphic data indicate two biostratigraphic regions to the north and south of the Yarlungzangbo suture. The northern bioprovince contains an Early Triassic Tethyan assemblage with *Claraia aurita, C. claraia, C. intermedia, Entolium microtes,* and *Eumorphotis inaequicostata.* Also north of the suture in the Lhasa-Tanggula-Qamdo region is a late Anisian ammonite fauna containing *Paraceratites trinodosus* that may be correlated to the Triassic of the Austrian, Italian, and Alps in the former Yugoslavia, or more specifically the Anisian Reiflingkalk, Gasau, and northern Italian Brembana ammonite zones (Gu et al., 1980). The Himalayan Mountain Region south of the suture is a Gondwanan bioprovince, but Early Triassic taxa are conspicuously depauperate with only the bivalves *Claraia griesbachi, C. painkhandana,* and *C. dieneri* recorded. A Middle Triassic Anisian ammonite fauna here clearly reflects a different regional character as it is dissimilar to a contemporaneous fauna at Lhasa.

Mesozoic paleomagnetic stratigraphy also indicates relatively large discrepancies in paleolatitude position north and south of the Yarlungzangbo suture, although data is still insufficient for further determinations.

Stratigraphy, biogeography, and paleomagnetic data suggest that the Yarlungzangbo suture constitutes a continental suture line, as earlier proposed by Gansser (1980). Consequently, in the Early Triassic, or earlier, the Yarlungzangbo region was probably an open marine realm, while the Himalayan region south of the suture formed the northern margin of the Gondwanan continent that was separated from its northern Laurasian counterpart by an expansive sea. Further studies are required to confirm these hypotheses.

Chinese Triassic Chronostratigrahy

1. Marine Triassic Chronostratigraphic Subdivisions

Questions Regarding the Subdivision of South China Marine Triassic Stages and Epochs.

The majority of South China represents a Tethyan realm and therefore basically correlates to Triassic systems in the European Alps, such as a portion of the Muschelkalk in the German Triassic. However, a small portion is also correlated to the Japanese littoral Pacific realm and the Upper Triassic of eastern Siberia.

At the beginning of the century, several Chinese workers adopted the three epochs and six stages of the Triassic from the European Alps and applied the nomenclature to South China marine facies. These included the subdivisions established by the French geologist J. Deprat (1912) at Kaiyuan, Yunnan Province, where European stage names such as Ladinian and Carnian were applied and later retained by Chinese geologists such as Xu and Chen (1943). The two Chinese workers later recognized the Scythian, Anisian, Ladinian, and Carnian, after studying the Qingyan and Guanling ranges. In subdividing the Triassic of Mile, Yunnan, Wang (1945) made correlations to the European Reible, Wengen, and other formations. In addition, Loczy (1898), Misch (1941), and others recognized that Chinese ammonite and bivalve faunas had close affinities to those in the German Wellenkalk and Muschelkalk.

The lower Triassic boundary has yet to be recognized in the European Alps. The Lower Triassic Werfen Formation is subdivided into the Seizer and Campiler subunits, but they contain no diagnostic fossil zones and only formational nomenclature is employed. When Zhao (1959) studied the Lower Triassic ammonite faunas of western Guangxi Province, he applied the two Russian stages of Kiparisova and Popov (1956) and five substages of Spath (1934). These subdivisions (see below) were in continuous use in China for 20 years.

Since the 1970s a new phase of global Triassic research has been undertaken, with progress in the revisions and establishment of new subdivisions. These include: (1) A redefinition of the stages and substages in the classic Alpine Triassic, including stage and substage boundaries. Examples include the proposal to synonymize the “Hydasp” with the Lower Anisian (Assereto, 1973), the opinion to abolish the lower Carnian Cordeval Substage (Krystyn, 1973), and stipulations for the concepts and fossil zonations of the Rhaetic Stage (Kozur, 1972; Tozer, 1971; Urichs, 1972). (2) New proposals have been made to erect Lower Triassic subdivisions, and discussions were conducted regarding their intercontinental correlations. These stages were first designated the Griesbachian, Dienerian, Smithian, and Spathian (Tozer 1967, 1978), but were subsequently revised to the three stages Greisbach, Nammalian, and Spathian (Guex, 1978).

In China, a revision of the entire South China marine Triassic was proposed. One suggestion expanded ammonite faunas from two to three; another discussion probed the boundary

problems of the Anisian, Ladinian, and Carnian; and a third proposal suggested further research into Rhaetic equivalent stratigraphic units. The most recent "Guidebook on International Stratigraphy" and two guidebooks on Chinese stratigraphy have erected stratotype sections, delineated upper and lower zones, appointed stage nomenclature, and proposed itineraries to expand and develop research into Chinese Triassic Subdivisions.

South China Triassic Marine Subdivisions (see Table 2)

Lower Triassic: The type section consists of the Luolou Fm. in the Lingyun-Tianlin region of western Guangxi Province. Strata contains abundant ammonites, and approximately several tens of meters to up to 150 m of predominantly marls that grade to limestones, shales, and mudstones. Two stages and four substages are recognized as follows:

Olenekian

Columbitan

(3) *Procarnites-Leiophyllites* Zone

(2) *Columbites costatus* Zone

(1) *Tirolites darweni* Zone

Owenitan

(2) *Pseudowenites oxynotus* Zone

(1) *Owenites costatus* Zone

Induan

Flemingitan

(2) *Koninckites lingyunensis* Zone

(1) *Proptychites kwangsiensis* Zone

Gyronitan

(1) *Vishnuites marginalis* Zone

Paleontological data in the western Guangxi Lower Triassic are deficient, indicating that the Otoceratan or Griesbachian stages at the base of the Induan are absent. At the top of the section, the Columbitan Substage is also incomplete, but this may be the result of faulting. Most recently the Regional Geologic Investigative Brigade of Guangxi discovered *Ophiceras sinensis* Tien, and *O. tingi* Tien, in the Langping cross-section of Tianlin, which according to Tien (1943), correlates to the most basal stratigraphic units in Guizhou Province and other regions. Consequently, a supplemental *Ophiceras sinensis* Zone is recognized in Guangxi.

To further supplement the deficiencies in the Guangxi Lower Triassic, it is possible to refer to the Kangshar Fm. (originally the base of the Tulong Group) in the Mt. Everest region of Tibet. The type section is located on Mt. Selong Xishan near Tulong Village, Nyalam Co. According to Himalayan work conducted by Academia Sinica (1974), the Kangshar Fm. is a complex of thinly laminated carbonates assigned to the Induan and Olenekian stages, with the Induan Stage only

represented by 3-10 m of sediment. Wang and He (1976) recognize three ammonite zones in the Induan, from bottom to top as the *Otoceras latilobatum* Zone, the *Ophiceras (Lytophiceras) sakuntala* Zone, and the *Gyronites psilogyrus* Zone.

In addition, it is proposed here to strengthen the use of other benthic faunal complexes to subdivide Triassic sediments that either lack completely or contain very few ammonites. The lower Triassic in the Yangzi region of southeast China consists of red clastics to carbonates with an abundant benthic fauna that is extremely similar to assemblages in the European Werfen Fm.. However, data from the Triassic Conference on the Southern Alps indicates that the Werfen is not reliably constrained, and thus should not be used for comparison. Conversely, as the Yangzi Lower Triassic has undergone extensive research, it may function as a reference section (see Table 2). The following Lower Triassic subdivisions have been recognized on the Yangzi Platform by Xu and Chen (1944), Wang, Chen, and Lu (1963), and Yin (1962): the *Claraia wangi* Zone, *C. aurita* Zone, *Eumorphotis multiformis* Zone, *Pteria murchisoni* Zone, and the *Tirolites cassianus* Zone.

Middle Triassic: Representative Anisian and Ladinian sections are recognized in the Qingyan Fm. at Qingyanzhen Village, Guiyang Co., and the Falang Fm. at Longchang,[**] Zhenfeng Autonomous Co., in southern Guizhou Province.

Anisian: The Qingyan Fm. is a nearly 900 m complex of variegated (blue-gray, yellow-green) shales grading to carbonates. The sequence is exceptionally fossiliferous, containing corals, brachiopods, bivalves, gastropods, ammonites, and echinoderms. The Qingyan fauna has undergone study by Xu (1943), Yin (1962), and others. Y.G. Wang (1964)[**] recognized three zones among the Qingyan ammonites. From bottom to top these are designated the *Paraceratites trinodosus* Zone containing *Discoptychites*; the *Paraceratites binodosus* Zone containing *P.* n. sp., and *Bulogites* n. sp.; and the *Nicomedites yohi* Zone containing the genus *Beyrichites.* Wang correlated these three zones to the international Anisian *P. trinodosus, P. binodosus,* and *Nicomedites osmani* zones (Chen, 1979). Wang also erected the new basal Anisian *Parpopanoceras nanum* Zone, based on a fauna from the vicinity of Yangpuna, Xinchang, Anshun Co. These four zones thereby represent the lower, middle and upper Anisian Stage. It is necessary to note that the *P. nanum* Zone at Anshun has yet to be adequately constrained, such that its relationship to the Qingyan ammonite zones is still vague. Underlying the *N. osmani* Zone in the Qingyan cross-section, the 108 Guizhou Geological Brigade discovered a *Leiophyllites-Usurites* ammonite unit which may correlate to the *P. nanum* Zone. This zone contains the taxa *Parapopanoceras, Leiophyllites, Danubites, Hollandites, Judicarnites,* and *Procarnites,* and correlates to the Aegian Substage in the Eastern Mediterranean, and the *Lenotropites caurus* Zone of North America.

Ladinian: The Falang Fm. is represented at Longchang, Zhenfeng Co. and Langdai, Liuzhi Co., where it has been studied by Yin (1962), Wang (1964, unpublished), and others. Wang recognized two ammonite zones: the lower *Protrachyceras primum* Zone was only recognized in the 297.5 m thick thinly laminated carbonates at Langdai, Liuzhi. The upper *P. reitzi* Zone consists of 167-998 m of mudstones and argillaceous shales. Each of these may be correlated to the *P. reitzi* and *P. archaelaus* zones in the European Alps. The *Daonella lommeli* and *Halobia kui* bivalve assemblage in the Falang Fm. may also be correlated to the Wengen in the southern Alps.

Upper Triassic: Numerous Late Triassic ammonite horizons are recognized in the Mt. Everest region of Tibet, western Yunnan and northwestern Sichuan Provinces. Although a

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[**] The type section of the Falang Fm. at Falangcun Village, Ganling Co. itself is unsuitable.

[**] *Ammonites from Central and Southern Guizhou Province* (unpublished manuscript).

detailed subdivision of these units has not been undertaken, several provisional ammonite zones are recognized in the Mt. Everest region (Wang and He, 1976; Wang et al., 1980).

Carnian: This stage is represented in type section of the Zhamor Fm. (upper Tulong Group) near Tulong Village, Nyalam Co., Tibet. Lithologic characters consist of 99 m of sandy shale and quartz sands interbedded with bioclastic limestones abundant in ammonites, bivalves, brachiopods, and bryozoans. Fragments of ichthyosaurs are also noted from the top of the section. Yin (in Academia Sinica, 1974) and Wang and He (1976) discussed three Carnian ammonite zones from bottom to top as the *Indonesites dieneri* Unit, the *Hoplotropites* Zone, and the *Parahauerites acutus* Zone. They recognized the assemblages as distinctly upper Carnian and correlated them to the *Tropites subbullatus, T. dilleri,* and *T. welleri* Zones in the Western Himalayas, European Alps, and Canada. More advanced work is required to diagnose zones for the lower Carnian.

Norian: This stage is represented by 1,235 m of the Qulong Gongba and Dashalong fms. at the Longjiang Xishan and Surshan cross-sections of Tingri, Tulongcun Village, Nyalam Co., Tibet. Investigations conducted by Ji (in Academia Sinica, 1974) describe the Dashalong Fm. as 287 m of interbedded gray carbonates, sandy shales, and calcareous siltstones. The Qulong Gongba Fm. consists of 948 m of interbedded gray sandstones and calcareous siltstones. Norian fossils are exceptionally abundant, with over 100 species of ammonites, bivalves, gastropods, brachiopods, and ichthyosaurs recorded. Wang and He (1976) recognized five Norian ammonite zones in southern Tibet from bottom to top as: (1) the *Nodotibetites nodosus* Zone, (2) the *Greisbachites-Gonionotites* Zone, (3) the *Indojuvavites angulatus* Zone, (4) the *Cyrtopleurites socius* Zone, and (5) the *Pinacoceras metterbichi* Zone. This last zone was later redesignated the *Himavavites columbianus* Zone.* Wang and He further state that the Lower Norian *N. nodosus* Zone in southern Tibet is a distinct ammonite fauna that may supplement deficient contemporaneous faunas in Western Tibet. In addition, the *Griesbachites-Gonionotites* Zone correlates to the Lower Norian ammonite zone in the Thini region of Nepal; the two middle Norian zones (3) and (4) are regarded as equivalent to the Western Himalayan *I. angulutus* horizon, a portion of the Diener *Halorites* Zone, and the European Middle Norian *C. bicrenatus* beds. The last zone (5) is generally equivalent to the lower upper Norian.

Rhaetic: This stage is possibly represented in the upper Derong Fm. at the Nyalam Tulongcun cross-section in Tibet (Academia Sinica, 1974; Wang and He, 1976). The upper 394 m of section may be Rhaetic in age but is unconfirmed as the strata is unfossiliferous. The 591 m lower and middle members of the section, however, consist of white to brown quartz sands lacking in ammonites and producing only the Norian bivalves *Nuyculana yunnanensis* Reed, *Myophoria (Costatoria)* sp., and *M. (Neoschizodus) laevigata* Ziethen.

2. The Continental Triassic Sequence

North China Triassic continental facies are lithologically complete, relatively extensively spread, and predominantly exposed in the Qinshui, Ningwu, Junggar, and Turfan basins, in addition to the Shaanganning Basin. Only small scattered exposures lie in the northern Qilian Mts., Hexi Corridor in western Gansu, western Henan, Hebei, and Shandong provinces, and northeast China. Within these basins, the most representative continental Triassic section is recognized in the Shaanganning Basin, where there has been a relatively high degree of research conducted on fossiliferously abundant stratigraphic sequences.

Lower Triassic: This stage is represented by the Liujiagou and Heshanggou Fms. which are extensively distributed in Shaanxi and Shanxi provinces in North China. Recognition of the Lower Triassic boundary in this region is dependent on which subdivision of the Permo-Triassic

* Unpublished data from *The Stratigraphy of China-Triassic System*.

Shiqianfeng Group is accepted. Since the erection of the nomenclature "Shihchienfeng Series" by the Swedish Geologist E. Norin (1924), there have been consistent controversies regarding the diagnosis of stratigraphic ages. In 1959, the Shanxi Stratigraphic Brigade from Academia Sinica subdivided the Shiqianfeng Fm. into the Sunjiagou, Liujiagou, and Heshanggou members. The First National Stratigraphic Congress later formally recognized the Shiqianfeng Fm. as Late Permian. In the 1960s, biostratigraphic work in the Shanxi Basin was conducted by the Institute of Geology, Chinese Academy of Geology, where geologists assigned the Sunjiagou Member, currently synonymized with the Shiqianfeng Fm., to the Late Permian, while the Liujiagou and Heshanggou Fms. were assigned to the Early Triassic (Institute of Geology, 1980). These age assignments were later confirmed by the discovery of a *Pleuromeia* flora and diagnostic pollen complexes in the Heshangou and Liujiagou fms. in eastern Shanxi Province (Wang, Xie, and Wang, 1978).

The type section of the Liujiagou Fm. (T_1l) lies at Sunjiagou, Ningwu Co., Shanxi Province, although a more representative section is recognized at Peijiashan, Jiaocheng Co., Shanxi. Lithologies consist of 360-600 m of light purple-red, fine-grained arkosic quartz sands grading to well-developed cross-beds with magnetite "veins" and "bands." Current ripples, mudcracks and "sand balls" are present. The sediments are in conformable contact with the underlying Shiqianfeng Fm. The upper part of the formation produces a macro-plant assemblage dominated by *Pleuromeia jiaochengensis* Wang (MS), *P. rossica* Neuburg, *Crematopteris* sp., and *Yuccites* sp., in addition to a *Lundbladispora-Taeniaesporites-Cycadopites* pollen complex.

The type section for the overlying Heshanggou Fm. is at the same locality as the prior Liujiagou Fm., but a more representative section is recognized at Hongyatou, Yushe Co., Shanxi Province. Lithologies consist of 103-280 m of brick red or tan-red mudstones and sandy mudstones that are in conformable contact with the underlying Liujiagou Fm. At Yushe and Pingyao, Shanxi Province, the lower part of the formation produces macro-plant fossils including *Pleuromeia sternbergi* (Munster) Corda, *Pl. rosica* Neuberg, *Yuccites*? sp., *Voltzia* sp., *Equisetites* sp., *Neocalamites* sp., and cf. *Anomopteris mougeoti* Schimper. In contemporaneous strata at Fugu, Shaanxi Province, a *Verrucosisporites-Lundbladispora-Taeniaesporites* pollen complex is found, and at the top of the unit vertebrates occur including *Fugusuchus hejiapanensis* Cheng, Procolophonidae, Benthosuchidae, and *Ceratodus heshangouensis* Cheng. Ostracods include *Darwinula fragilis* Schneider, *D. rotundata* Lubimova, *D. ingrata* Lubimova, and *D. triassiana* Belousova.

In the Junggar and Turpan basins of Xinjiang, strata equivalent to the Liujiagou and Heshanggou Fms. are known as the Jiucaiyuan and Shaofanggou fms. within the Cangfanggou Group. These also consist of a set of red clastics 103-280 m thick that lie conformably on the underlying Upper Permian, which is also recognized as part of the Cangfanggou Group. The Jiucaiyuan Fm. consists of tan-red mudstones and gray-green sandstones that produce predominently *Lystrosaurus* with occurrences of *Chasmatosaurus*. Ostracods include *Darwinula minuta* Mand, *D. ingrata* Lubimova, *D. breva* Gal., and *D. adducta* Lubimova. Pollen include *Nevesisporites, Annulispora, Verrucosisporites, Lundbladispora,* and *Kraeuselisporites.* Gymnosperms (including seed ferns) include the ribbed bisaccate *Striatites* and *Taeniaesporites* in addition to the unribbed bisaccate *Pinuspollenites, Podocarpidites,* and *Caytonipollenites*. The Shaofanggou Fm. consists of purple-red sandstones grading to mudstones that frequently contain carbonate concretions. To date, fossil data is restricted to pollen with a relatively high content of *Taeniaesporites* and *Cycadopites.* Its age is also regarded as Early Triassic.

The Liujiagou and Heshanggou fms. in the Shaanxi and Shanxi regions contain a *Pleuromeia* flora and a pollen complex that permits a correlation to the middle to upper Buntsandstein of Germany, and the Russian Vetluzhian Stage and Baskunchakian (Bogdinian) Suite.

In Xinjiang, the *Lystrosaurus* Fauna from the Jiucaiyuan Fm. may be correlated to the *Lystrosaurus* Zone from the South African Middle Beaufort Fm. In addition, the presence of *Chasmatosaurus* and an ostracod assemblage allows correlation to the variegated ostracod and thecodont bearing early Early Triassic sediments of the Vetluzhian Group on the Russian Platform.

Middle Triassic: The distribution of the Ermaying and Tongchuan fms. is equivalent to the Lower Triassic sediments described above. The type section of the Ermaying Fm. (T_2*er*) is at Ermaying in Ningwu Co., Shanxi, but a more representative section is at the Xiqinshi cross-section of Heshun Co. The 416-700 m thick formation is composed of two members. The lower member consists of gray-green, gray-yellow, and deep red moderately fine grained arkosic sandstones. The upper member consists of dark purple sandy mudstones with calcareous and gypsiferous concretions. An abundant *Kannemeyeria* dicynodont fauna is produced including *Sinokannemeyeria, Parakannemeyeria,* and *Shansisuchus* (Sun, 1963). Macro-plant fossils include *Protoblechnum wongii* Halle, *Todites shensiensis* (Pan), *Aipteris wuziwanensis* Zhou and Huang, *Pachypteris* sp., *Bernoullia* cf. *zeilleri* Pan, *Sphenobaiera* sp., *Annalepis* sp., *Pleuromeia wuzwanensis* Zhou and Huang, and *Voltzia walchiaeformis* Fliche. A *Punctatisporites-Chordasporites-Plicatipollenites* pollen complex is also present. In general, these complexes are Middle Triassic.

The Tongchuan Fm. (T_2*t*) type section is at Jinxiaoguan, Tongchuan Co., Shaanxi Province. The name was established by the Institute of Geology, Chinese Academy of Geology, as a means of subdividing the original Yanchang Group. The Institute designated the lower portion's T_{3yl}-T_{3y2} as the Tongchuan Fm. and the upper T_{3y3}-T_{3y5} as the Yanchang Fm. (in the restricted sense). Lithologically, the Tongchuan Fm. consists of 600 m of gray-green, gray-red, massive arkosic quartz sands and gray-black shales, or oil-shales, that lie conformably on the underlying Ermaying Fm. Macro-plants recovered include *Tongchuanophyllum concinum* Zhou and Huang, *Danaeopsis magnifolia* Zhou and Huang, *Pleuromeia? tongchuanensis* Zhou and Huang, *Glossopteris? chinensis* Zhou and Huang, *Neocalamites* sp., and *Equisetites?*. A *Punctatisporites-Granulatisporites gigantus-Chordaspoirites* pollen complex is also recorded here.

In Xinjiang, the Karamay (Kelamayi) Fm. in the Xiaoquangou Group is equivalent to the Ermaying and Tongchuan fms. The lower section consists of predominantly red mudstones grading to gray-green sandstones that produce a *Kannemeyeria* fauna. The upper section consists of predominantly gray-green mudstones grading to red sandstones and mudstones that produce fish including *Bogdanta, Fukangolepis,* and *Fugangichthys* (Su, 1978).

The aforementioned *Kannemeyeria* fauna may be correlated to the South African *Cynognathus* Zone in the upper Beaufort Fm., which is recognized as Middle Triassic by a majority of paleontologists and stratigraphers (Elden, 1973; Haughton, 1963). The flora in the North China Tongchuan Fm. is more archaic than the Yanchang Flora but may still be generally correlated to the South African lower Molteno Beds and German upper Muschelkalk. The upper Karamay Fm. in Xinjiang, however, is believed to be early Late Triassic due to the presence of *Bogdanta* and *Fukangolepis.*

Upper Triassic: The Yanchang Fm. is currently recognized as the middle and upper sections of the former Yanchang Group (T_{3y3}-T_{3y5}). The type section lies at Yanchang, Shaanxi Province, but a more representative section is noted at Qishuihe, Tongchuan, Shaanxi.

Lithologically, the formation consists of over 4 m of gray and gray-green arkosic sandstones and sandy shales with the upper section containing carbonaceous units. Sediments predominantly produce the Yanchang Flora consisting of *Danaeopsis fecunda* Halle, *Bernoullia zeilleri* Pan, *Todites shensiensis* (Pan), and *Glossophyllum? shensiensis* Sze, in addition to a pollen complex consisting of *Dictryophyllidites-Apiculatisporis-Leuckisporites triassicus*. These are regarded as Upper Triassic (Institute of Geology, 1980; Si and Zhou, 1964; Si, 1956). Strata equivalent to this formation in Xinjiang include the Haojiagou and Huangshanjie Fms. in the upper Xiaochuangou Group, the Nanyinger Group in Gansu Province, and the Gailde Goinba Fm. in the Qilian Range of Qinghai Province. All of these units are predominantly a set of gray-green clastics that produce a Yanchang Flora.

European Upper Triassic flora that may be correlated to the Yanchang Fm. include those from the Lunzer Keuper in Austria, the Baser Keuper in Switzerland, and strata along the Illek River in western Kazakhstan. Flora from these sediments are all dominated by a *Danaeopsis-Bernoullia-Glossophyllum* complex (Institute of Geology, 1980; Kopytova, 1965), and are associated with distinctly similar pollen complexes (Institute of Geology, 1980; Faddeeva, 1965).

Triassic Boundaries in China

1. The Lower Triassic Boundary in South China Marine Facies

As the Permo-Triassic boundary is based upon Paleozoic-Mesozoic faunal replacement in addition to catastrophic changes in geologic history, it has been subjected to serious scrutiny by Chinese and other international workers for more than a decade. Numerous specialists have devoted themselves to the study of this boundary by organizing research conferences (Calgari, 1971), publishing monographs (Logan and Hill, 1973), and organizing international geological organizations (including the International Geological Correlation Project-IGCP). Despite these efforts, a general consensus defining the Permo-Triassic boundary has not been reached and this situation is expected to remain as such until the end of the century.

Two viewpoints dominate the dispute over the Permo-Triassic boundary, as summarized below:

1. In many of the major Permo-Triassic cross-sections sedimentation is discontinuous at the boundary. This is observed at Zhulfa in the former Soviet Union, Kuh-e-Alibash in Iran, the Salt Range in Pakistan, and Shal-Shal Cliff in India. Opinions vary as to whether or not there is a global deposional hiatus at this boundary (Teichert et al., 1973; Tozer, 1972; Zhao et al., 1980).

2. Permian taxa are found mixed within diagnostic Triassic assemblages. These include the brachiopods *Crurithyris* and *Pinomarginifera*, and the conodont *Anchignathodus typicalis*. Their association has led to several boundary hypotheses:

a. The *Otoceras woodwardi* Zone is the basal boundary of the Triassic (Tozer, 1972; Kummel and Teichert, 1970; Nakazawa et al., 1975).

b. Conodont research recognizes the boundary between the upper and lower Griesbachian Stage (Kozur, 1974).

c. Ammonites and other faunas suggest that the boundary lies above the *Otoceras-Ophiceras* zone (Newell, 1973).

d. The appearance and increase of Triassic ammonites in the Smithian Stage suggest that the boundary should be drawn at the base of this stage (Waterhouse, 1973).

Chinese workers concur that the *Otoceras woodwardi* Zone is the base of the Triassic (Zhao et al., 1980; Yang et al, 1980) and have published opinions regarding the depositional continuity of Permo-Triassic systems, since in China there is observed both the youngest Permian (the Changxing Stage) and the oldest Triassic (*Otoceras* Zone). This text supports this viewpoint, which has received international attention, but is still not publicly acknowledged. Data from recent Chinese geological work in the marine realm suggest that the Permo-Triassic boundary may be recognized in two models with three facies:

Model I. Permo-Triassic conformable sedimentation is recognized with either a mixed fauna (Permian brachiopods present in the Triassic) or pure fauna (Permian brachiopods absent in the Triassic).

1. Examples of conformable sedimentation with mixed faunas:

a. At Wenxingchang, Chungking (Chongqing), Sichuan Province, the Permian Changxing Fm. consists of a cherty limestone containing *Palaeofusulina.* Conformably overlying this is the Triassic Yelang Fm. with a base of 2.08 m of thinly laminated argillaceous limestone that shares the bivalve*Claraia wangi* Patte and the brachiopod *Crurithyris* with the underlying unit.

b. At the Laga cross-section at the town of Langdai, Liuzhi, Guizhou, the Changxing Fm. is conformable with the overlying Feixianguan Fm. At the base of the Feixianguan Fm. are two units of montmorillonitic clay, above which is a gray-green mudstone containing the mixed assemblage of *Claria wangi* (Patte), *Crurithyris, Hollinella tingi* (Patte), and *Langdaia subobologa* Wang.

c. At the cross-section of Jiangning, Hushan Co., Jiangsu, the Xiaqinglong Fm. produces *Ophiceras* sp. and the bivalves *Claraia* cf. *wangi* (Patte) and *Eumorphotis?*; near its base is a 0.3 m yellow-green dolomitic mudstone that contains *Crurithyris?* sp. and *Chonetes* sp. and which is conformable with the top of the Dalong Fm. consisting of shales and siliceous shales grading to a small amount of limestone.

d. At Baoqing, Changxing Co., Jiangsu Province, the Qinglong Group consists of carbonates. At its base are yellow-green dolomitic marls that contain the productid brachiopod *Waagenites* and the spirifer brachiopod *Crurithyris* which co-occur with *Otoceras?* and *Claraia.* The basal marls are conformable with the top of the Changxing Fm., which is characterized by dark gray massive calcareous dolomites that contain *Palaeofusulina* cf. *chinensis* Sheng, *Spinomarginifera keichouensis Huang,* and *Tapashanites* sp.

2. Examples of conformable sediments with pure faunas:

a. At the Longfeng Commune and Wuquan, Wangcan Co. cross-sections in northern Sichuan the Fengxianguan facies (clastics) contain either no ammonites or ammonites are rare. But at the base of the Fengxianguan Fm. the Triassic *Ophiceras-Claraia wangi* Zone is recognized conformably overlying the Permian Dalong Fm.

b. At the Fengxianguan and Chaotian cross-sections at Guangyuan Co., northern Sichuan, the Yelang facies (transitional phase between clastics and carbonates) represent the basal Triassic and consists of gray limestone grading to yellow shales that contain the bivalves *Claraia* cf. *wangi* (Patte) and *C. stachei* Bittner. This conformably overlies the Permian Dalong Fm.

c. At the Yujiao cross-section of Longli Co., Guizhou, the Changxing Fm. produces the ammonites *Permodoceras* and *Pleuronodoceras* in addition to the trilobite *Arcopyge.* Conformably overlying this unit are 4 m of gray shales that produce *Claraia* sp., followed by 4 m of dark gray shales grading to thinly laminated carbonates that produce *Lytophiceras* cf. *commune* Spath. This

in turn is followed by 6 m of dark gray micritic limestone grading to shales and marls that contain the ammonites *Prinolobus* cf. *impressus* Waagen, *Paranorites linguisellatus* Chao, *P.* cf. *ovalis* Chao, *Ophiceras sinensis* Tien, *Vishnuites* sp., *Koninckites* cf. *ellipticus* (Tien), *Anakashmirites* sp., *Proptychites* sp., *Clypeoceras* sp., and *Lytophiceras* cf. *commune* Spath, in addition to the bivalves *Claraia* cf. *aurita* (Hauer), *C. concentrica* (Yabe), and *Phaedrysmamytilus* sp. The basal 4 m of fossiliferous Triassic carbonates are assigned to the *Ophiceras sinensis* Zone. Its boundary with the underlying Changxing Stage (Changxing carbonates) is extremely distinct.*

Model II. A distinct disconformity or paraconformity bounds the Permian and Triassic. The former is represented by a depositional hiatus and erosional surface, while the latter is represented by a faunal hiatus but lacks an accompanying erosional surface. Examples include:

a. In the Rongjing-Tienquan region of the Xinjiang-Yunnan terrane, Lower Triassic purple-red clastics directly and disconformably overlie Permian basalts.

b. In the Donglan-Hechi vicinity of northern Guangxi, Lower Triassic *Claraia* -bearing shales directly and paraconformably overlie the Permian Maokou Fm.

In summary, the marine Permo-Triassic boundary in China may be regionally recognized beneath the Otoceratan (the *Otoceras-ophiceras* and *Claraia wangi* Patte, *C. griesbach* Bittner) Daye Facies, or the *Claraia wangi* (Patte) bivalve zone conformable clastics. Several mixed facies with "Paleozoic" brachiopods represent a remnant fauna from a massive extinction, or a Permo-Triassic replacement stage.

2. The Lower Triassic Boundary in North China Terrestrial Facies

In most regions of North China, terrestrial Permian and Triassic systems are represented by depositional continuity. However, the boundary consists of poorly fossiliferous red clastics, causing long-standing controversies regarding boundary recognition. Over the past ten years geological research on North China geology has expanded to provide new subdivision hypotheses.

Permo-Triassic sedimentation is continuous and fossiliferous in the Qinshui and Shaanganning basins to provide suitable field areas for the solving of the boundary problems. Research conducted by the Institute of Geology (1980) and the Shanxi Regional Survey Brigade (Wang et al., 1978) indicates that the Permo-Triassic boundary in the Qinshui and Shaanganning basins should be drawn between the Shiqianfeng and Liujiagou fms. Paleontological justification for this includes the following:

a. At the top of the Shiqianfeng Fm. at Lixialing, Baode Co., Shanxi, the pareiasaur *Shihtienfenia* allows a correlation to *Pareiasaurus* and *Propappus* from the Upper Permian *Cistecephalus* Zone of South Africa (Young and Ye, 1963).

b. At Xuecun, Lishi Co., Shanxi, *Shansisaurus xuecunensis* Cheng and Tapinocephalidae are recovered from the Shiqianfeng Fm. This allows correlations to the Late Permian *Pareiasaurus* from South Africa and *Scutosaurus* beds from Russia. In South Africa tapinocephalids are recovered from Late Permian or older sediments as well as in the former Soviet Union (Young and Ye, 1963).

* Data from the 108 Guizhou Geological Brigade.

c. In the lower Shiqianfeng Fm. of Liulinchuan, Yaoxian Co., Shaanxi, the megaflora *Noeggerathiopsis* sp. and *Glossopteris?* sp.[**] are recovered, which resembles the Permian Kuznyetskian Flora in Russia.

d. Pollen is also recovered from the Shiqianfeng Fm. at Lishi, Shanxi, that is totally dominated by gymnosperms, and particularly by the bisaccate ribbed and striated *Striatites, Taeniaesporites* sp., and *Lueckisporites virkkiae* Pot. and Kl. Secondary occurrences of the archaic conifers *Cordaitina* and *Potonieisporites* are also present. Spores are rare. The assemblage is very similar to those from the Permian Yevlashevo Fm. of the Kuznyet (Kuznetsk) Basin in Russia, and may also be correlated to European sediments containing *Ullmannia*.

e. At Paijiashan and Yaoertou, Jiaocheng Co., Shanxi, the upper Liujiagou Fm. (330 m from the base) produces nearly flawless specimens of *Pleuromeia jiaochengensis* Wang (MS) and *P.* cf. *rossica* Neuberg, in addition to *Crematopteris* sp., *Neocalamites* sp., and *Taeniopteris* sp. Among these, *P.* cf. *rossica* Neuberg is an indicator for the German Triassic Buntsandstein. A particularly characteristic pollen assemblage is also recovered from the Jiaocheng sediments, identified as the *Lundbladispora-Taeniaesporites-Cycadopites* Complex, and which may be correlated to Early Triassic pollen complexes from the Salt Range in Pakistan and the Bolshoy Kavkaz region of Russia.

f. Fossil vertebrates do not occur in the Liujiagou Fm. of the Shaanganning Basin. But the overlying Heshanggou Fm. produces Procolophonidae and *Fugusuchus*, allowing a correlation to the South African Procolophon Zone, or late Early Triassic. Consequently, the underlying Liujiagou Fm. should be early Early Triassic, or equivalent to the South African *Lystrosaurus* Zone.

g. Worth noting are marine bivalves that have been collected in the past several years at the cross-section of Sishiya, Linyou, Shaanxi from the "Shiqianfeng" Fm. including *Palaeoneilo elliptica* (Goldfuss), *Unionites* spp., *Pteria* cf. *murchisoni* Geinitz, *Bakevellia costata* (Schlotheim), *Gervillia exporecta* (Lepsius), and *Mytilus eduliformis subpraecursur* Yin, in addition to the asterozoan echinoderm *Ophiolepis shaanxiensis* Yang, which indicate the lower Olenekian, Early Triassic, and not Permian stage (Yang et al., 1980). Investigations conducted by the Institute of Geology confirm that a Permian *Lueckisporites-Protohaploxypinus* pollen complex occurs in the lower "Shiqianfeng" sediments at Sishiya which resembles a complex produced from the Shiqianfeng Fm. at Lishi, Shanxi. Consequently, the sediments at Sishiya are reliably assigned to the Shiqianfeng Fm. Moreover, higher in the Sishiya section, a pollen complex dominated by *Lundbladispora* and *Taeniaesporites* may be confidently correlated to the Triassic Liujiagou Fm. at Jiaocheng, Shanxi, which contains a *Lundbladispora-Taeniaesporites-Cycadopites* complex. In conclusion, the marine upper Sishiya sediments may be recognized as contemporaneous but a different facies of the Liujiagou Fm. The name Qishan Fm. is hereby proposed for these sediments with the Permo-Triassic boundary clearly recognized between the Shiqianfeng and Qishan formations.

Permo-Triassic sedimentological continuity is recognized in the Cangfanggou Group within the Junggar and Turpan basins of Xinjiang, where the four formations present from bottom to top aredesignated the Quanzijia, Wutonggou, Jiucaiyuan, and Shaofanggou fms. This is the most appropriate region for determining boundary problems as significant fossil vertebrates are recovered from the sediments.

Sun (1973) described *Striodon, Jimusaria*, and *Kunpania* from the top of the Wutonggou Fm. at the northern foot of the Bogdashan Mts. in the southern Junggar Basin, which are correlated to the *Cistecephalus* Zone in the Karoo System of South Africa. In the overlying

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[**] Diagnoses provided by S.Z. Zhang and L.H. Deng.

Jiucaiyuan Fm., taxa such as *Lystrosaurus, Chasmatosaurus, Urumchia* and labrinthodont amphibians are recovered, allowing a correlation to the South African *Lystrosaurus* Zone. Therefore, the Lower Triassic boundary may be confidently drawn at the basal boundary of the Jiucaiyuan Fm. Unpublished data from the Xinjiang Office of Petroleum discusses abundant fossil plants in the Wutonggou Fm. including *Callipteris zeilleri* Zal., *C. altaica* Zal., *Iniopteris sibirica* Zal., *Comia dentata* Kodey, and *Protoblechnum wangii* Halle. This floral complexion is similar to the Permian flora recovered from the Russian Kuznyet Basin, confirming a Late Permian age. To date, no megaflora has been recovered from the Jiucaiyuan Fm., but pollen research conducted upon the Wutonggou Fm. by the Institute of Geology indicates a predominance of gymnosperms, most importantly with *Lueckisporites virkkiae* Pot. and Kl., *Protohaploxypinus, Klausipollenites, Striatopodocarpites, Vittatina,* and *Cordaitina,* which may be correlated to the Late Permian Yevlashevo Fm. of the Kuznetsk Basin and the Dada Fm. of Central Asia. In the Jiucaiyuan Fm. ferns exceed gymnosperms. The most common taxa include *Nevesisporites, Annulispora, Verrucosisporites, Osmundacidites, Lundbladispora,* and *Kraeuselisporites,* in addition to the pteridophyte *Apiculatisporis.* Gymnosperms (including seed ferns) are represented by the bisaccate and ribbed *Striatites* and *Taeniaesporites,* in addition to the unribbed bisaccate *Pinuspollenites, Podocarpidites,* and *Caytonipollenites.* The Triassic Jiucaiyuan assemblage differs from the Wutonggou complex in its absence of the Permian taxa *Lueckisporites virkkiae, Cordaitina,* and *Vittatina,* and instead a replacement by the Triassic *Lundbladispora* and *Aratrisporites.* The Jiucaiyuan complex is distinctly similar to an Early Triassic assemblage from Kazakhstan.

4. Summary of Chinese Triassic Paleogeography

1. In the Late Permian, the Hercynian Movement eliminated a long-standing marine trough (the Tianshan-Xingan Trough), and led to the orogeny of a vast terrestrial block along a lineament north of the Kunlun-Qinling mountain ranges to create mountain systems and plateaus with synchronous basin topography. South of the Qinling-Kunlun lineament was a vast marine realm containing three corridors that linked the Tethys to the Pacific oceans: the Palmir-Kunlun, Kashmir-Yarlungzangbo, and Suwanxiayangzi corridors. Subsequently, in the Triassic, three marine transgressions occurred: the first Early to Middle Triassic Anisian transgression submerged the China and Xinjiang-Yunnan terranes where a complex of clastics and carbonates were deposited within a realm of archipelagos and embayments. Widespread xeric adapted flora inhabited the continents under a xeric and hot climate, while along the continental margins evaporites and red clastics were deposited with a well-developed tropical fauna. This constituted a continuation of the hot Permian climate.

2. Middle Triassic paleogeography was fundamentally consistent with that of the Early Triassic by maintaining a pattern of northern continents and southern marine realms bounded by the Motian Range and Xinjiang-Yunnan terrane. To the east lay a stable marine depositional region but to the west, mobilized marine troughs dominated the region. However, revived orogenic activity and expansion of the Jiangnan terrane unified the Cathaysian terrane which distinctly reduced the marine realm to the east. The uplift of the eastern Yangzi region reversed the direction of facies formation in the Early Triassic and there was an increase of clastic deposition eastward with a synchronous reduction of carbonate deposition. During the Ladinian, the orogeny of the entire eastern region was accompanied by a large-scale marine regression and intense marine trough subsidence to the west.

3. Indosinian movement in the late Middle Triassic continued to the end of this period to create new geomorphological patterns in China in the Late Triassic. In eastern China along the Taihangshan-Xuefengshan lineament there appeared sedimentary models and faunas that differed from west to east, as the west consisted of subsided marine troughs associated with intermediate massifs. By the end of the Triassic there was distinct southward accretion of the Asian continent.

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Appendix I

Pinyin - Wade Giles

Adula - A tu la
Anren - An jen
Badong - Pa tong
Bangonghu - Pan kung hu
Baoqing - Pao ch'ing
Bolila - Po li la
Cangfangou - T'san fang kou
Changdu - Ch'ang tu
Chaotian - Ch'ao t'ien
Chengkoufanxian - Ch'eng k'ou fan hsien
Changjiang - Ch'ang chiang
Dalong - Ta lung
Daye - Ta yeh
Dingjiayao - Ting chia yao
Donglan - Tung lan
Duogaila - Tuo kai la
Feixianguan - Fei hsien kuan
Fugu - Fu ku
Fujian - Fu chien
Gansu - Kan su
Ganzi - Kan tze
Genkou - Ken k'ou
Guangdong - Kuang tung
Guangxi - Kuang hsi
Guangyuan - Kuang yuan
Guiyang - Kui yang
Guizhou - Kuei chou
Haojiagou - Hao chia kou
Heilongjiang - Hei lung chiang
Heshanggou - Ho shang kou
Honghe - Hungho
Huangmaqing - Huang ma ch'ing
Hubei - Hu pei
Jiangnan - Chiang nan
Jiangxi - Chiang hsi
Jiaocheng - Chiao ch'eng
Jiapila - Chia p'i la
Jilin - Chi lin
Jinshajiang - Chin sha chiang
Jinxiaoguan - Chin hsiao kuan
Jiucaiyuan - Chiu ts'ai yuan
Kaijiang - K'ai chiang
Kaiyuan - K'ai yuan
Kunlun - K'un lun
Lancanjiang - Lan ts'an chiang
Langdai - Lang tai
Leikoupo - Lei k'ou p'o
Litang - Li t'ang
Longmen - Lung men
Longwuhe - Lung wu ho
Lueyang - Lueh yang
Luoluo - Lolo
Luzhou - Lu chou
Maqin - Ma ch'in
Minhe - Min ho
Nanyinger - Nan ying er
Ningxia - Ning hsia
Nujiang - Nu chiang
Paijiashan - P'ai chia shan
Peijiashan - P'ei chia shan
Pingtang - P'ing t'ang
Pingyao - P'ing yao
Qinghai - Ch'ing hai
Qingyan - Ch'ing yen
Qilian - Ch'i lien
Qingling Ch'in ling
Qinshui - Ch'in hsueh
Qishan - Ch'i shan
Qishuihe - Ch'i shui ho
Qiuling - Ch'iu ling
Quanzijia - Ch'uan tzu chia
Rongjing - Jong ching
Shaanxi - Shen hsi
Shanxi - Shan hsi
Shanggou - Shang kou
Shangxian - Shang hsien
Shiqianfeng - Shih ch'ien feng
Shiwandashan - Shih wan ta shan
Sichuan - Szu ch'uan
Songpan - Sung p'an
Sunjiagou - Ts'un chia kou
Sishiya - Szu shih ya
Tanggula - T'ang ku la
Tianquan - T'ien ch'uan
Tianshan - T'ien shan
Tongchuan - T'ong ch'uan
Wenxingchang - Wen hsing ch'ang
Wuquan - Wu ch'uan
Wutonggou - Wu t'ong kou
Wuzao - Wu tsao
Xiaqinglong - Hsia ch'ing long
Xianshuijiashan - Hsien hsueh chia sha
Xiaojiangkou - Hsiao chiang k'ou
Xiaoquangou - Hsiao ch'uan kou
Xidagou - Hsi ta kou
Xikou - Hsi k'ou

Xiqingshi - Hsi ch’in shih
Xiwei - Hsi wei
Xinchang - Hsin ch’ang
Xinjiang - Hsin chiang
Yanchang - Yen ch’ang
Yaoxian - Yao hsien
Yangzi - Yang tzu
Yelang - Yehlang
Yidun - I tun
Yining - I ning
Youjiang - Yu chiang
Yunkai - Yun k’ai
Zhejiang - Che chiang
Zhenfeng - Chenfeng
Zhongdian - Chong tien
Zhouzhi - Chou chih

Appendix II

Wade-Giles to Pinyin

An jen - Anren
A tu la - Adula
Ch'ang tu - Changdu
Ch'ao t'ien - Chaotien
Che chiang - Zhejiang
Chen feng - Zhenfeng
Ch'eng k'ou fan hsien - Chengkoufanxian
Chi lin - Jilin
Ch'i lien - Qilian
Ch'i shui ho - Qishuihe
Ch'ang chiang
Chia p'i la - Jiapila
Chiang nan - Jiang nan
Chiang hsi - Jiangxi
Chiao ch'eng - Jiaocheng
Chin hsiao kuan - Jinxiaoguan
Ch'in hsueh - Qinshui
Ch'in ling - Qinling
Chin sha chiang - Jinshajiang
Ch'ing hai - Qinghai
Ch'ing yen - Qingyan
Ch'i shan - Qishan
Ch'iu ling - Qiuling
Chiu ts'ai yuan - Jiucaiyuan
Chou chi h- Zhouzhi
Ch'uan tzu chia - Quanzijia
Chung tien - Zhongdian
Fei hsien kuan - Feixianguan
Fu chien - Fujian
Fu ku - Fugu
Hao chia kou - Haojiagou
Hei lung chiang - Heilongjiang
Ho shang kou - Heshanggou
Hsi ch'in shih - Xiqinshi
Hsi k'ou - Xikou
Hsi ta kou - Xidagou
Hsi wei - Xiwei
Hsia ch'ing lung - Xiaqinglong
Hsiao chiang k'ou - Xiaojiangkou
Hsiao ch'uan kou - Xiaoquangou
Hsien hsueh chia shan - Xianxuejiashan
Hsin chiang - Xinjiang
Hsin ch'ang - Xinchang
Huang ma ch'ing - Huangmaqing
Hungho - Honghe
Hu pei - Hubei
I tun - Yidun
I ning - Yining
Jong ching - Rongjing
K'ai chiang - Kaijiang
K'ai yuan - Kaiyuan
Kan su - Gansu
Kan tze - Ganzi
Ken k'ou - Genkou
Kuang hsi - Guangxi
Kuang tung - Guangdong
Kuang yuan - Guangyuan
Kuei chou - Guizhou
Kui yang - Guiyang
K'un lun - Kunlun
Lang tai - Langdai
Lan ts'an chiang - Lancanjiang
Lei k'ou p'o - Leikoupo
Li t'ang - Litang
Liu chia kou - Liujiagou
Liu chih - Liuzhi
Lolo - Luoluo
Lu chou - Luzhou
Lueh yang - Lueyang
Lung ch'ang - Longchang
Lung men - Longmen
Lung wu ho - Longwuhe
Ma ch'in - Maqin
Minhe - Min ho
Nan ying er - Nanyinger
Ning hsia - Ningxia
Nu chiang - Nujiang
P'ai chia shan - Paijiashan
Pan kung hu - Bangonghu
Pao ch'ing - Baoqing
Pa tong - Badong
P'ei chia shan - Peijiashan
P'ing t'ang - Pingtang
P'ing yao - Pingyao
Po li la - Bolila
Shan hsi - Shanxi
Shang kou - Shanggou
Shang hsien - Shangxian
Shen hsi - Shaanxi
Shih ch'ien feng - Shiqianfeng
Shih wan ta shan - Shiwandashan
Sung p'an - Songpan

Szu ch’uan - Sichuan
Szu shih ya - Sishiya
Ta lung - Dalong
T’ang ku la - Tanggula
Ta yeh - Daye
Ting chia yao - Dingjiayao
T’ien ch’uan - Tianquan
T’ien shan - Tianshan
T’san fang kou - Canfanggou
Ts’un chia kou - Sunjiagou
T’ong ch’uan - Tongchuan
Tung lan - Donglan
Tuo kai la - Duogaila
Wen hsing ch’ang - Wen hsing ch’ang
Wu ch’uan - Wuquan
Wu tsao - Wuzao
Wu t’ong kou - Wutonggou
Yang tzu - Yangzi
Yao hsien - Yaoxian
Yeh lang - Yelang
Yen ch’ang - Yanchang
Yu chiang - Youjiang
Yun k’ai - Yunkai