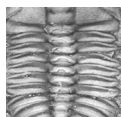


# Tentative correlation of Cambrian Series 2 between South China and other continents

JINLIANG YUAN, XUEJIAN ZHU, JIHPAI LIN & MAOYAN ZHU



The apparent absence, in Cambrian Series 2, of widespread and rapidly evolving organisms comparable to the later agnostids, graptolites, conodonts, ammonites, or planktonic foraminifers, has prevented a consistent intercontinental biostratigraphy. Occasional genera, and (rarely) species, of trilobites, archaeocyathans and other groups may be found in more than one region. Nevertheless, based on the complete trilobite and archaeocyathan successions in the shallow water Yangtze Platform and in deeper water Jiangnan Slope environment, correlation of Cambrian Series 2 between South China and other continents is discussed in detail. The oldest trilobite *Parabadiella* and *Tsunyiidiscus* in South China can be correlated with the oldest trilobite *Abadiella* in Australia, *Profallotapis* in Siberia and *Eofallotaspis* in Morocco.

• Key words: Cambrian Series 2, correlation, South China, other continents.

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International correlation of Cambrian Series 2 has been a major problem since the concept of four series within the Cambrian was established (Peng & Babcock 2005).

Three principal problems hamper effective inter-continental correlation of Cambrian Series 2 rocks and faunas. First, the high endemicity of Cambrian trilobite faunas is controlled by lithofacies, different environments have been sampled in different regions: Siberian, Australian, and Antarctic Cambrian Series 2 faunas are predominately from carbonate regimes; Moroccan, Spanish, Chinese, Avalonian, and Baltic faunas are from predominately siliciclastic regimes; and Laurentian faunas are mostly from inner shelf siliciclastics and shelf carbonates. Second, there were strong biofacies controls on the details of Cambrian associations within each of the major paleogeographic regions, including 3 main faunal Realms: the Oriental Realm, the Occidental Realm and the Medial Realm (Lu *et al.* 1974a), but evaluation of these controls for much of the world remains uncertain. Finally, there was a well-differentiated biogeography through much of Cambrian Series 2 time, because even comparable lithofacies on different Cambrian continents do not always contain comparable faunal elements; and palaeogeographies that reflect the macrofacies are not yet available for all areas (Lu *et al.* 1974a, Palmer 1998). In addition, substantial hiatuses in the stratigraphic record, and inconsistencies in taxonomic

nomenclature lead to paucity of biostratigraphically useful data in key regions (Palmer 1998, Geyer 2001).

Widespread and rapidly evolving organisms, comparable to the later agnostids, graptolites, conodonts, ammonites, or planktonic foraminifers, are generally lacking in Cambrian Series 2 making it more difficult to achieve a consistent intercontinental biostratigraphy. Occasional genera, and (rarely) species of trilobites, archaeocyathans and other classes may be found in more than one region, but often correlations depend on faunal similarities at the family level.

Nevertheless, some trilobite assemblages are considered to have potential for correlation. The first level is the base of the Cambrian Series 2, defined by the FAD of trilobites. There are different opinions about correlation of the oldest trilobite-bearing beds of China with other continents, especially with the Siberian Platform (S.G. Zhang 1982; Zhang *et al.* 1980; Zhang 1987; Repina 1986; Landing 1994; Zhuravlev 1995; Shergold 1997; Peng *et al.* 2004, 2006; Babcock *et al.* 2007; Paterson & Brock 2007) (Table 1).

The Fallotaspidoidea in the early Atdabanian in Siberia, the early Issendalenian in Morocco, the early Waucoban in North America, was considered to include the earliest trilobites and ancestral to other trilobites (Shergold 1997, Jell 2003).

**Table 1.** Comparative correlations of the oldest trilobite-bearing beds of China into Siberian Lower Cambrian trilobite biostratigraphy.

Stage	Trilobite zonation	Repina 1986	S.G. Zhang (1982), Zhang (1987)	Landing (1994)	Zhuravlev (1995), Paterson & Brock (2007)	Shergold (1997)	Peng <i>et al.</i> (2006)	Zhang (2003), this paper
Botomian				XXXXX				
	<i>Judomia-Uktaspis</i> Zone				XXXXX			
Atdabanian	<i>Delgadella anabara</i> Zone	XXXXX				XXXXX		
	<i>Fallotaspis</i> Zone						XXXXX	
	<i>Profallotaspis</i> Zone							XXXXX
Tommotian			XXXXX					

XXXXX The oldest trilobite-bearing beds of China

However, *Lemdadella* Sdzuy, 1978 is one of the oldest Cambrian trilobites so far known from the Lemdad area of Morocco and southern Spain (Liñán & Sdzuy 1978, Palmer & Rowell 1995). This genus was found in Spain in lower part of the *Fallotaspis* Zone, and found in Antarctica associated with *Yunnanocephalus* of the *Eoredlichia-Yunnanocephalus* Zone of later Chiungchussuan in SW China (Palmer & Rowell 1995), *Fallotaspis* Zone is the same age of *Eoredlichia-Yunnanocephalus*, and younger than *Parabadiella* Zone in SW-China. Therefore the *Parabadiella* Zone may be time-equivalent to *Eofallotaspis* Zone in Morocco and *Profallotaspis jakutensis* Zone in Siberia.

The second level is *Hupeidiscus fengdongensis-Estaingia (Zhuxiella) fangxianensis* Zone from the middle-upper part of the Jiumenchong Formation in southeastern Guizhou or middle-upper part of the Shuijingtuo Formation in Hubei of early Tsanglangpuan (= Canglangpuan) in SW China. In the early Tsanglangpuan there exists a Liangshuijing Archaeocyathid Assemblage including rich *Cambrocyathellus*, *Aldanocyathus*, *Rotundocyathus*, *Sibiricyathus*, *Taylorcyathus*, *Coscinocyathus*, *Chengkoucyathus*, *Protopharetra*, *Dictyocyathus* and others (Zhang 1982, pp. 521, 522), of which *Cambrocyathellus*, *Dictyocyathus* and *Coscinocyathus* were flourishing during the middle-later Tommotian in Siberian Platform. Besides, *Fomitshella* Missarzhevsky, 1969 (*F. yankonensis* Yuan & Zhang, 1983) has been reported from the early Tsanglangpuan of northern Guizhou and in Siberia they occur mainly in the Tommotian and early Atdabanian (Missarzhevsky 1974, Varlamov *et al.* 2008). *Delgadella anabara* (Lazarenko, 1962) occurs in the late Atdabanian on the Siberian Platform (Varlamov *et al.* 2008), and *Delgadella* may derive from *Hebediscus* Whitehouse, 1939 (Jell 1975, Zhang *et al.* 1980), while *Hebediscus* Whitehouse, 1939 may have evolved from the oldest eodiscoid *Hupeidiscus* or *Tsunyidiscus*, which range biostratigraphically from lower part of *Eoredlichia-Yunnanocephalus* Zone (late Chiungchussuan) to *Drepanuroides* Zone (early Tsanglangpuan) (Lin 2008; Yang *et al.* 2003, 2005). Therefore, *Delgadella anabara* Zone should be much younger than *Hupeidiscus orientalis* Zone or

*Tsunyidiscus niutitangensis* Zone in South China Slope area. The first true Hebediscidae, *Delgadella* Walcott, 1912, appears in the *Delgadella anabara-Nevadella* Zone in the later Atdabanian. However, the Hebediscidae is not as old as the Tsunyidiscidae including *Hupeidiscus*, *Shizhudiscus*, *Tsunyidiscus*, because the genera assigned to Hebediscidae, *Delgadella*, *Hebediscus*, and *Hebediscina* have wider glabella and pygidial axis, narrower fixigenae between palpebral lobes. Therefore the late Atdabanian in Siberia can be correlated with the early Tsanglangpuan in Southwest China.

The third level is *Ichangia-Neocobboldia* Zone. *Neocobboldia dentata* (Lermontova, 1940) from the *Bergeroniellus micmacciformis-Erbiella* Zone at the base of the Botomian is similar to *N. minor* Zhou in Zhou & Lin, 1978 from the uppermost Shuijingtuo Formation (Zhou & Lin 1978, p. 145, pl. 20, figs 1–4; Sun 1984, pl. 119, figs 4, 5), and they may be synonymous. Therefore *Ichangia-Neocobboldia* Zone of middle Tsanglangpuan for South China and *Bergeroniellus micmacciformis-Erbiella* Zone on the Siberian Platform may be correlated. Besides, abundance of syringocnemidids, korovinellids and claruscoscinids among the archaeocyathans allows correlation of the upper Botomian *Bergeroniellus ornata* Zone in Siberia with the *Syringocyathus aspectabilis* Zone of the Altay-Sayan Foldbelt, the Yingzuiyan Archaeocyathid Assemblage of the Yangtze Platform, SW China, the *Jebileticoscinus-Paranacyathus-Porocyathus* Assemblage of Morocco, and the *Pycnoidocoscinus serratus-Tabulaconus kordeae* Zone of Laurentia (Zhuravlev 1995). In northern Gansu and northwestern Xinjiang, northwestern China and the Siberian Platform the trilobites *Serrodiscus*, *Calodiscus* and *Edelsteinaspis* have been recorded (T.R. Zhang 1987, Xiang & Zhang 1985, Zhuravlev 1995) allowing this level (middle Tsanglangpuan) to be correlated with the lower-middle Botomian.

The fourth level is *Protolenella conica-Chengkouia* Zone or *Paokannia-Szechuanolenus* Zone. From *Ichangia-Neocobboldia* Zone to *Protolenella conica-Chengkouia* Zone or from *Ushbaspis* Zone to *Paokannia-Szechuanolenus* Zone there is a distinctly regressive

event in Southwest China. This level coincides with the global Hawke Bay regressive event. The base of Cambrian Stage 4 would be defined by the FAD of *Redlichia* or *Olenellus* (Peng et al. 2004, 2006; Babcock et al. 2007). The oldest species of *Redlichia* so far known from SW-China is *Redlichia (R.) premigena* Lin & Yin in Zhang et al. 1980 (Zhang et al. 1980, p. 125, pl. 19, figs 3–5) within the *Paokannia-Szechuanolenus* Zone and *Ushbaspis* Zone of the middle Tsanglangpuan (= Canglangpuan), which is intermediate between the *Palaeolenus lantenoisi* Zone (late Tsanglangpuan) and the *Drepanuroides* Zone (early Tsanglangpuan) or between *Protolenella conioca-Chengkouia* Zone and *Arthricocephalus jiangkouensis* Zone. In this interval trilobite faunal turnover is obvious. The older redlichiods and eodiscoids including Pararedlichiinae, Anadoxididae, Tsunyidiscidae, Hebediscidae disappear; protolenids and yinitids are dominated (Yuan et al. 2002). Sharp faunal changes can be observed in those areas between the earliest Toyonian and middle Toyonian in Siberia, and at the bottom of the *Olenellus* Zone in Laurentia, at the base of the *Hupeiolenus* Zone in Morocco, approximately at the base of the *Hamatolenus ibericus* Zone in Spain, which should be allowed to correlate this level in SW China with those levels above mentioned in other continents (Palmer & Repina 1997, Yuan & Zhao 1999).

The fifth level is *Arthricocephalus chauveaui* Zone. FAD of *Arthricocephalus chauveaui* was defined for the base of the Duyunian Stage (Peng & Babcock 2001). Later, Geyer suggested that FAD of *Arthricocephalus chauveaui* is marked the base of traditional Middle Cambrian (Geyer 2005). In Southwest China *Arthricocephalus chauveaui* Zone is time-equivalent to the *Palaeolenus deprati* Zone and *P. fengyangensis* Zone of later Tsanglangpuan (= Canglangpuan). The trilobite *Schistocephalus* Lermontova in Tchernysheva et al., 1956 is a junior homonym of *Schistocephalus* Creplin, 1829 (Özdikmen, 2009) and a junior synonym of *Palaeolenus* Mansuy, 1912 (Rushton & Powell, 1998), therefore *Schistocephalus antiquus* Tchernysheva in Tchernysheva et al., 1956 should be replaced by *Palaeolenus antiquus* (Tchernysheva in Tchernysheva et al., 1956). Morphologically this species is quite similar to *Palaeolenus fengyangensis* Chu, 1959, with which it may be synonymous. The Mass extinction of archaocyaths took place during this interval, which coincides with Botomian-Toyonian crisis between the *Anabaraspis splendens* Zone and *Lermontovia grandis* Zone of Toyonian in Siberian Platform (Brasier et al. 1994). Thus the early Amgan *Palaeolenus antiquus* Zone in Siberia can be correlated with *Palaeolenus fengyangensis* Zone or upper part of the *Arthricocephalus chauveaui* Zone in South China.

The sixth level is *Dinesus panxinicus-Olenoides constrictus* Zone of the lower-middle part of the

“Tsingshutung Formation” (middle Duyunian or early Lungwangmiaolan) in SE Guizhou, SW China. With exception of *Dinesus panxinicus*, *Olenoides constrictus*, many trilobite genera and species occur in this interval, such as, *Redlichia*, *Kootenia*, ?*Kooteniella*, *Panxinella angustilimbata* Lin in Lu et al., 1974a, *P. xiunaoensis* Qian & Lin in Zhang et al., 1980, *Changaspis plana* (Tomashpolskaya, 1960), *Lancastria*, *Parachangaspis* including *Kunshanaspis*, ptychopariids and the vestiges of *Arthricocephalus*. Morphologically, *Dinesus panxinicus* Zhu & Yuan in Zhu et al., 2009 (pl. 1, figs 5–12) is quite similar to *Dinesus granulatus* (Lermontova, 1940) and *Dinesus sibiricus* (Schmidt, 1886), which range from *Lermontovia grandis* Zone through the *Anabaraspis splendens* Zone, *Palaeolenus antiquus* Zone, and *Ovatoryctocara* Zone to *Kounamkites* Zone (Egorova et al. 1976, Repina & Romenenko 1978); *Olenoides constrictus* (Chien, 1961) is widely distributed not only in SW China, but also in North Greenland, where *Olenoides* sp. A. from the lower part of the Henson Gletscher Formation can be assigned to *Olenoides constrictus* (Chien, 1961) (Blaker & Peel 1997, p. 86, figs 42.2, 8, 9; 49.10); *Arthricocephalus* occurs both in the early–middle Duyunian (from *Arthricocephalus jiangkouensis* Zone to the lower part of *Ovatoryctocara* cf. *granulata-Bathynotus holopygus* Zone) of SW China, the upper *Olenellus* Zone of North Greenland and the Jigaimara Formation (earliest Templetonian), Arafura Basin, Northern Territory, Australia (Yuan et al. 2009, Blaker & Peel 1997, Laurie 2006). Therefore, *Dinesus panxinicus-Olenoides constrictus* Zone can be correlated with upper *Palaeolenus antiquus* Zone and lower *Ovatoryctocara* Zone in Siberia, and the upper *Olenellus* Zone in Laurentia.

The seventh level is *Ovatoryctocara* cf. *granulata-Bathynotus holopygus* Zone. *Ovatoryctocara granulata* has been found not only in the early Amgan *Ovatoryctocara* Zone in Siberia, but also in the upper *Olenellus* Zone in North Greenland. *Bathynotus* is widespread in South China, NW China, western and eastern Laurentia, Siberia and Australia (Peng et al. 2009, Webster 2009).

The eighth level is the *Oryctocephalus indicus* Zone. The FAD of *Oryctocephalus indicus* is defined the base of Cambrian Stage 5 and Cambrian Series 3. This species is widespread in South China, Himalaya (India), Korea, North America and Siberia (Yuan et al. 1997, 2002; Zhao et al. 2006, 2007); this level also corresponds to the second mass extinction of trilobites (Yuan et al. 2002). The base of *Oryctocephalus indicus* Zone corresponds to the base of the *Kounamkites* Zone on the Siberian Platform, the base of *Oryctocephalus indicus* Zone or *Poliella denticulata* Zone or *Oryctocephalus indicus* Zone in Laurentia (Sundberg & McCollum 1997, 2003a, b).

The South Australian *Abadiella huoi* Zone correlates with the *Parabadiella* Zone based on the occurrence of

Table 2. Correlation of Cambrian Series 2 between South China and other continents.

	South China Platform	South China Slope	Siberia	Australia	Morocco	Spain	Laurentia	
Cambrian Series 2	Lungwangmiaoan	<i>Paragraulus</i> - <i>Chittidia</i> Z. <i>Redlichia</i> <i>guizhouensis</i> Z. <i>R. murakamii</i> - <i>Hoffetella</i> Z. <i>R. iantenoisi</i> Z.	<i>Ovatoryctocara</i> cf. <i>granulata</i> - <i>Bathynotus</i> <i>holopygus</i> Z. ■ <i>Protoryctocephalus</i> <i>wuxunensis</i> Z.	<i>Xystridura</i> <i>negrina</i> ass. <i>Redlichia</i> <i>forresti</i> ass.	<i>Ornamentaspis</i> <i>frequens</i> Z. <i>Morocconus</i> <i>notabilis</i> Z.	Leonian	<i>Eokochaspis</i> <i>nodosa</i> Z.  <i>Bonnia</i> - <i>Olenellus</i> Z.	FAD of <i>O. indicus</i>
		<i>Palaeolenus</i> ★ <i>fengyangensis</i> Z.  <i>P. iantenoisi</i> Z.	<i>Arthricocephalus</i> <i>taijiangensis</i> Z. <i>Arthricocephalus</i> <i>chauveaui</i> Z. ●	<i>Palaeolenus</i> <i>antiquus</i> Z. ★ <i>A. splendens</i> Z. <i>L. grandis</i> Z.	Tissafinian		<i>Acadoparadoxides</i> <i>mureoensis</i> Z.	FAD of <i>Arthricocephalus</i> <i>chauveaui</i>
	<i>Paokannia</i> - <i>Szechuanolenus</i> - <i>Ushbaspis</i> Z.  <i>Drepanuroides</i> Z.	<i>Protolenella</i> <i>conica</i> - <i>Chengkouia</i> <i>pustulosa</i> Z.  <i>Drepanuroides</i> Z.	<i>Pararaia</i> <i>janeae</i> Z.  <i>B. ornata</i> Z. <i>B. asiaticus</i> Z. <i>B. gurarii</i> Z. <i>B. micmaciformis</i> - <i>Erbilla</i> Z.	Babanian		<i>Huolenus</i> Z.	<i>Hamatolenus</i> <i>ibericus</i> Z.	FAD of <i>A. jiangkouensis</i>
	<i>Yiliangella</i> - <i>Yunnanaspis</i> Z.  <i>Malungia</i> Z.	<i>Hupeidiscus</i> <i>fengdongensis</i> - <i>Neocobboldia</i> Z.	<i>P. bunyerooensis</i> Z.		Marianian	<i>Sectigena</i> Z.  <i>Antatlasia</i> <i>guttapluviae</i> Z.	<i>Lusatiopsis</i> Z.	? FAD of <i>Redlichia</i> or <i>Olenellus</i>
<i>Chungchussuan</i>	<i>Hupeidiscus</i> <i>orientalis</i> - <i>Hunanocephalus</i> Z.  <i>Tsunyidiscus</i> <i>niultangtensis</i> Z.	<i>Judomia</i> - <i>Uktaspis</i> Z. <i>Delgadella</i> <i>anabara</i> - <i>Nevadella</i> Z. <i>Repinaella</i> Z.  <i>Profallotaspis</i> <i>jakutensis</i> Z.	<i>P. tatei</i> Z.  <i>Abadiella</i> <i>huoi</i> Z.	<i>A. hollardi</i> Z.  <i>Daguinaspis</i> Z. <i>Choubertella</i> Z. <i>Fallotaspis</i> <i>tazemmourtensis</i> Z. <i>Eofallotaspis</i> Z.		<i>Doleroenus</i> Z. ●  <i>Fallotaspis</i> Z. ☆	<i>Nevadella</i> Z.  <i>Fallotaspis</i> Z. ☆	? FAD of trilobite

■ *Ovatoryctocara granulata*      ■ *Bathynotus*      ★ *Palaeolenus*      ● *Arthricocephalus chauveaui*  
 \* *Necobboldia*      ○ *Eoredlichia*      ☆ *Lemdadella*

*P. huoi* in the both regions (Zhang 1985, 2003; Jell in Bengtson *et al.* 1990; Steiner *et al.* 2001; Zhang *et al.* 2001; Paterson & Brock 2007). The *Pararaia tateri* Zone from the Parara Limestone contains *Wutingaspis jelli* Zhang in Zhang *et al.*, 2001 and can be correlated with *Eoredlichia-Wutingaspis* Zone (Zhang *et al.* 2001). However, *Wutingaspis* ranges from upper part of *Parabadiella* Zone to *Eoredlichia* Zone (Luo *et al.* 1994, 2008), we establish here *Eoredlichia-Yunnanacephalus* assemblage Zone instead of *Eoredlichia-Wutingaspis* assemblage Zone. *Pararaia bunyerooensis* Zone and *Pararaia janeae* Zone contain *Hebediscina yuqingensis* (Zhang in Yin & Lee, 1978), which occurs in the middle-upper part of the Jiumengchong Formation in South China, which is time-equivalent to early–middle Tsanglangpuan in SW China. The co-occurrence of *Redlichia endoi* both in the *Micmaccaspis* assemblage in Australia and *Palaeolenus lantenoisi* Zone in SW China allows correlation of middle-late Tsanglangpuan with *Micmaccopsis* assemblage from the upper Wilkawillina Limestone (Zhang *et al.* 1980, Zhou & Yuan 1980, Paterson & Brock 2007); trilobites higher in the succession in Australia are found in only a few horizons, for example, known from the Billy Creek

Formation, the Wirrealpa Limestone, and from the upper part of the Moodlatana Formation (Paterson & Edgecombe 2006; Jell in Bengtson *et al.* 1990), of which *Redlichia guizhouensis* and *Bathynotus holopygus* occur both in SW China and South Australia (Jago *et al.* 2006, Paterson & Brock 2007), and are equivalent to late Duyunian or Lungwangmiaoan. It is worth noting that the *Arthricocephalus* sp. nov. has been recorded from the Jigaimara Formation, Arafura Basin, Northern Territory, and associated with *Pagetia* aff. *edura* Jeel, *Xystridura altera* Öpik, ptychoparioid sp. 1 and *Itagnostus* sp. of the early Templetonian in age (Laurie 2006). *Arthricocephalus* ranges from the Balang Formation, via the Wuxun Formation (“Tsingsutung Formation”) to the lowest part of the Kaili Formation (Duyunian or late Tsanglangpuan to Lungwangmiaoan) in SW China (Yuan *et al.* 2009). Besides, the *Xystridura*-bearing strata at Yaxian, Hainan Province was considered as a traditional lowermost Middle Cambrian (Lin & Jago 1993), however, the associated *Pagetia luoyacunensis* Lin & Jago was regarded as a possible synonym of *Kiskinella cristata* Romanenko & Romanenko, 1962, which occurs in *Ovatoryctocara granulata* Zone of Siberia, southeastern Newfoundland (Fletcher 2003, Geyer

2005), thus the *Xystridura*-bearing strata may probably belong to latest Duyunian. *Dinesus* was formerly regarded as a typical traditional early Middle Cambrian trilobite taxon (Jell & Adrain 2003), however, *Dinesus panxinicus* Zhu & Yuan in Zhu et al., 2009, *D. burus* (Qiu, 1980), *D. ocellatus* (Qiu, 1980), *D. spinellosus* (Zhou in Zhou et al., 1982) except *D. kirghizensis* Lermontova, 1951, occur in traditional Lower Cambrian in China (late Duyunian or late Lungwangmiaoan). Therefore the early Templetonian may be partly correlated with late Duyunian or late Lungwangmiaoan.

Lower Cambrian trilobite successions of Morocco have been well documented (Hupé 1953; Sdzuy 1978; Geyer 1990, 1996; Geyer & Landing 1995). The oldest trilobite *Lemdadella* Sdzuy, 1978 occurs in the *Fallotaspis tazemmourtensis* Zone. It seems reasonable the *Fallotaspis tazemmourtensis* Zone together with Calcaire Supérieur should be equivalent to the *Eoredlichia-Wutingaspis* Zone in SW China (Zhang 1998); while *Choubertella* Zone and *Daguinaspis* Zone of later Issendalenian may be correlated with uppermost *Eoredlichia-Yunnanoccephalus* Zone (latest Chiungchussuan) or *Malungia* Zone of earliest Tsanglangpuan in SW China. *Antatlasia hollardi* Zone, *Antatlasia gutta-pluviae* Zone and *Sectigena* Zone of the Banian may fall within the *Yiliangella-Yunnanaspis* Zone, *Drepanuroides* Zone and *Ushbaspis* Zone (early-middle Tsanglangpuan) in SW China. The base of the STH “Band” has been proposed as a GSSP for the base of a terminal “Lower Cambrian” stage, because associations with such trilobites as *Serrodiscus bellimarginatus*, *Triangulaspis annio*, *T. schucherti*, and *Hebediscus attleborensis* are distributed in the traditional Lower Cambrian (Cambrian Series 2) of western Avalonia, eastern Avalonia, Taconic Laurentia, West Gondwana, the Altay-Sayan fold Belt, the Siberian Platform, the Russian Far East region and with restrictions even in Laurentian Greenland and South Australia (Geyer, 2005). The *Hupeolenus* Zone of early Tisaffinian can be correlated with *Paokannia-Szechuanolenus* Zone (middle Tsanglangpuan), because *Szechuanolenus* Chang & Chu in Yin & Lee, 1978, with *S. nanjingensis* Chang & Chu in Yin & Lee, 1978 as the type species (Yin & Lee 1978, p. 424, pl. 152, figs 20, 21; Zhang et al. 1980, p. 236, pl. 75, figs 1–4), is quite similar to *Hupeolenus* Geyer, 1990, with *Protolenus (Hupeolenus) hupei* Geyer, 1990 as the type species (Geyer 1990, pp. 184–186, pl. 36, fig. 5; pl. 46, figs 1–18) in general outline of cranium and glabella, the pattern of lateral glabellar furrows, the width of fixigenae between palpebral lobes and the length and position of palpebral lobe. Therefore *Hupeolenus* may be a junior synonym of *Szechuanolenus*. The trilobite genus *Cephalopyge* Geyer, 1988 is a junior homonym of *Cephalopyge* Hanel, 1905 (Özdikmen, 2009), and the replacement name is *Morocconus* Özdikmen, 2009. In the *Morocconus notabilis* Zone *Palaeolenus ornatus* (Geyer,

1998) and *Shergoldiella vincenti* Geyer, 2006 have been recorded. Therefore *Morocconus notabilis* Zone may be a time equivalent to *Palaeolenus* Zone (latest Tsanglangpuan) and *Dinesus panxinicus-Olenoides constrictus* Zone (Lungwangmiaoan or later Duyunian), because a few illustrated specimens that were previously assigned to *Arthrocephalus chauveaui* Bergeron, 1899 from the Dachenling Formation of Dongzhi, southern Anhui should be reinterpreted as *Shergoldiella* cf. *S. sequei* (Liñán & Gozalo, 1999) (Zhu et al. 2005, Yuan et al. 2009).

Correlation of Cambrian Series 2 between South China and other continents is shown in Table 2.

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