

Estudios Geológicos
julio-diciembre 2019, 75(2), e119
ISSN-L: 0367-0449
<https://doi.org/10.3989/egeol.43595.574>

The trilobite biostratigraphy for the Balang and “Tsinghsutung” formations, Cambrian Series 2, Stage 4 in the Balang area, Jianhe, Guizhou, South China

Bioestratigrafía a partir de trilobites de las Formaciones de Balang y “Tsinghsutung” (Serie Cámbrica 2, Piso 4) en el área de Balang, Jianhe, Guizhou, China meridional

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ABSTRACT

Ongoing work is carrying out in the Balang and “Tsinghsutung” formations to aim a suitable candidate for the base of the Cambrian Series 2, Stage 4. The revision of the trilobite systematics and zonation shed light about the stratigraphic distribution and the geographical distribution of the new trilobite-based zones in the Balang area (South China). Our results suggest that either *Oryctocarella duyunensis* or *Arthricocephalus chauveaui* could be good candidates since they also occur in the *Eoaagnostus roddyi-Arthricocephalus chauveaui* Zone of the Henson Gletscher Formation, North Greenland.

Keywords: Trilobite biostratigraphy; Cambrian Series 2, Stage 4; Balang and “Tsinghsutung” formations; South China.

RESUMEN

Se está trabajando en las formaciones de Balang y “Tsinghsutung” para encontrar un candidato adecuado para la base de la Serie 2 del Cámbrico, Piso 4. La revisión de la sistemática y zonación bioestratigráfica de los trilobites arroja luz sobre las distribuciones estratigráfica y biogeográfica de las nuevas zonas basadas en trilobites en el área de Balang (China meridional). Nuestros resultados sugieren que tanto *Oryctocarella duyunensis* como *Arthricocephalus chauveaui* podrían ser buenos candidatos, ya que también se encuentran en la Zona de *Eoaagnostus roddyi-Arthricocephalus chauveaui* de la Formación de Henson Gletscher, al norte de Groenlandia.

Palabras clave: Bioestratigrafía con trilobites; Serie cámbrica 2, Piso 4; Formaciones de Balang y “Tsinghsutung”; China meridional.

Recibido el 10 de mayo de 2019; Aceptado el 5 de julio de 2019; Publicado online el 2 de diciembre de 2019

Citation / Cómo citar este artículo: Zhao, Y. et al. (2019). The trilobite biostratigraphy for the Balang and “Tsinghsutung” formations, Cambrian Series 2, Stage 4 in the Balang area, Jianhe, Guizhou, South China. *Estudios Geológicos* 75(2): e119. <https://doi.org/10.3989/egeol.43595.574>.

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Introduction

The International Subcommission on Cambrian Stratigraphy (ISCS) has undertaken an effort to divide the Cambrian System into four series and ten stages, among which the second series, as well as the second, third, fourth and tenth stages have long remained unnamed and poorly constrained. The GSSP proposal for provisional Series 3 and Stage 5, based on the Wuliu-Zengjiayan section near Balang village, Jianhe, Guizhou, South China, was ratified on June 21, 2018 and was named Miaolingian Series and Wuliuan Stage. Other five stages, the Fortunian, Drumian, Guzhangian, Paibian and Jiangshanian, were formally defined by GSSPs (Peng *et al.*, 2012).

Searching GSSP for the provisional Stage 4, Cambrian Series 2 is underway in the Jiaobang section, lying also near Balang village, Jianhe County. The section contains a continuous sequence of the Cambrian Series 2 with, in ascending stratigraphic order, the Bianmachong, Balang, “Tsinghsutung” and the lowermost part of the Kaili formations. A large collection of trilobites from the Balang and “Tsinghsutung” formations has provided an excellent fossil record to establish a new trilobite-based zonation with three new zones proposed below.

Trilobite Zones

Oryctocarella duyunensis Zone. This zone occupies the lower part of the Balang Formation and contains *Oryctocarella duyunensis*, *Duyunaspis duyunensis*, *Changaspis microtype*, *Redlichia (Pteroredlichia) chinensis*, and *Probowmania balangensis*. *Oryctocarella duyunensis* makes its first appearance at 1 m above the base of the Balang Formation (Figs. 1-2, 3e) (Zhao *et al.*, 2017).

Arthricocephalus chauveaui Zone. This zone occupies the middle-upper part of the Balang Formation through the middle-upper part of the “Tsinghsutung Formation” and includes *Arthricocephalus chauveaui (Haliplanktos jishouensis)*, *Arthricocephalus xinzhaiheensis*, *Oryctocarella duyunensis*, *Oryctocarella balangensis*, *Duyunaspis duyunensis*,

Cambrian	Miaolingia Series	Wuliuan Stage	<i>Oryctocephalus indicus</i> Zone
	Series 2	Stage 4 (Duyunian)	<i>Bathynotus kueichouensis - Ovatoryctocara sinensis</i> Ass. Z.
			<i>Protoryctocephalus arcticus</i> Zone
		“Tsinghsutung” Fm.	<i>Arthricocephalus chauveaui</i> Zone
			Balang Fm.
Stage 3 (Nanguan)			
		Kaili Fm.	

Figure 1.—Trilobite zonation chart of the Cambrian Series 2, Stage 4 in Jianhe, Guizhou, South China.

Changaspis microtype, *Redlichia (Pteroredlichia) murakammi*, *Probowmaniabalangensis*, *Olenoides cf. hubeiensis*, and *Olenoides constrictus*; In total, this trilobite Zone contains 7 genera and 10 species. *Arthricocephalus chauveaui* makes its first appearance at 85.8 m above the base of the Balang Formation (Figs. 1-2, 3a-b, 3d, 3f) (Peng *et al.*, 2015).

Protoryctocephalus arctiaius Zone. This zone occupies the middle-upper part of the “Tsinghsutung” Formation and contains *Protoryctocephalus arctiaius*, *Protoryctocephalus balangensis*, *Duyunaspis duyunensis*, *Redlichia (R.) nobilis* [= *Redlichia (R.) guizhouensis*], *Burlingia balangensis*, *Panxinella angustilimbata*, *Dinesus panxinensis* and a large number of ptychopariids, viz., *Nangops danzhaiensis*, *Balangcunaspis cransversu*, *Mufushania cf. nakingensis*, *Eosoptychoparia gaodongensis*, *Eosoptychoparia* sp. cf. *yunnanensis*, *Olenoides constrictus*, *Olenoides cf. hubeiensis*. This is also a trilobite diverse zone, having 15 genera and 18 species in total. *Protoryctocephalus arcticus* makes its first appearance at 162.2 m above the base of “Tsinghsutung” Formation (Figs. 1, 3c).

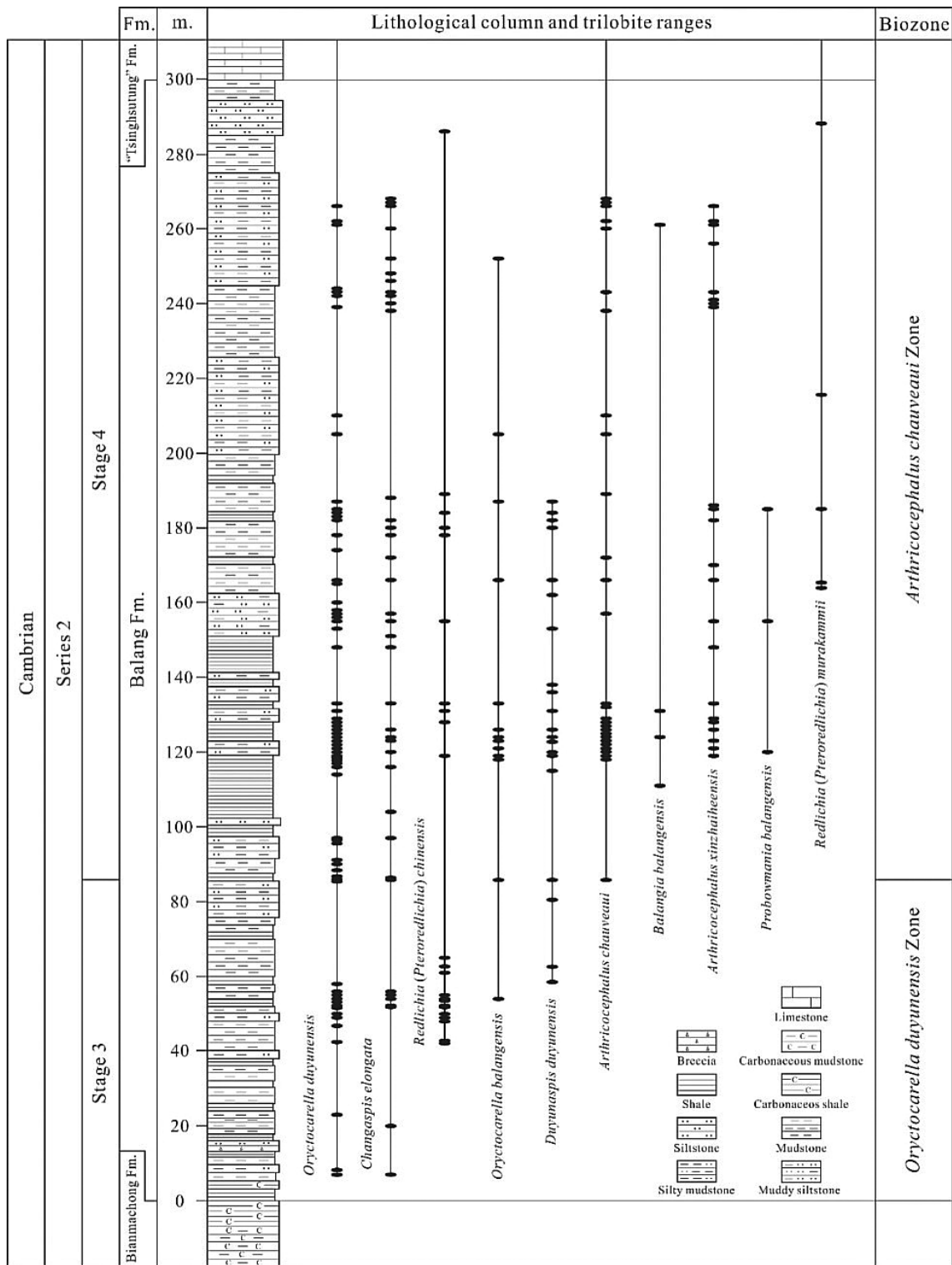


Figure 2.—Stratigraphic column of Balang Formation showing the trilobite distribution at Jiabang Section in Balang village, Jianhe County, Guizhou Province.

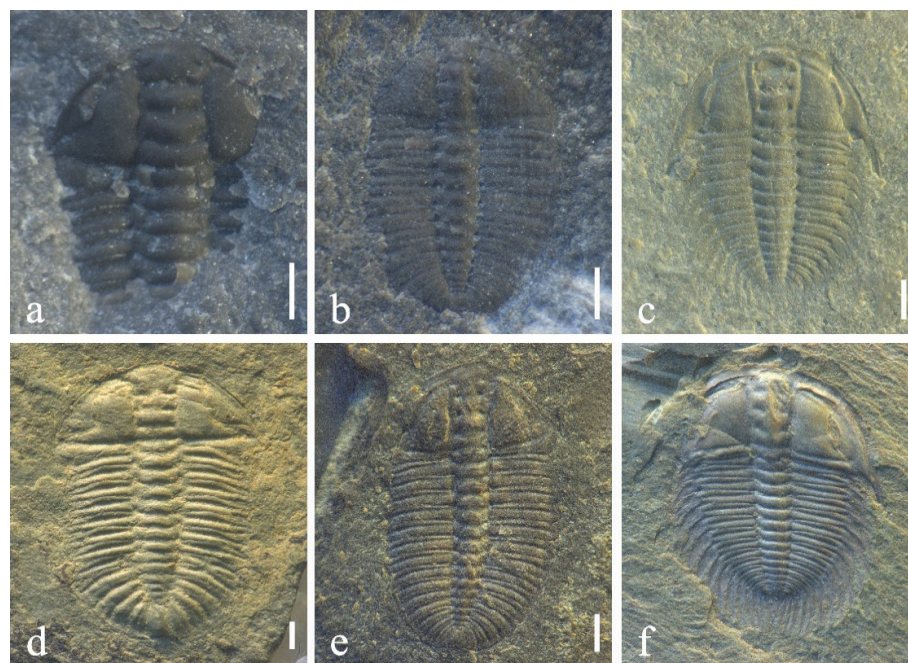


Figure 3.—Trilobites from the Balang and “Tsingsutung” formations. A-C. Trilobites from the “Tsingsutung” Formation, Songshan section, Balang village, Jianhe County, Guizhou Province, South China. A. *Arthrocephalus chauveaui*, dorsal exoskeleton (Q122-37). B. *Oryctocarella duyunensis*, dorsal exoskeleton (Q142-1). C. *Protoryctocephalus arcticus*, dorsal exoskeleton (Q51-511). D-F. Trilobites from the Balang Formation, Jiaobang section, Jiaobang village, Jianhe County, Guizhou Province, South China. D. *Arthrocephalus chauveaui*, dorsal exoskeleton (JJB-121-9). E. *Oryctocarella duyunensis*, dorsal exoskeleton (JJB-10-7). F. *Changaspis elangata*, dorsal exoskeleton (JJB-243-3). Specimens are deposited in the Palaeontological Centre of Guizhou, Guizhou University, Guiyang. All scale bars = 1 mm.

Remarks

Further work is necessary in the following years to erect the new Stage 4. So far, these three new trilobite zones show us that either the FAD of *Oryctocarella duyunensis* or FAD of *Arthrocephalus chauveaui* could be used to define the base of provisional Stage 4 (Peng *et al.*, 2017). This suggestion is based on the geographical record of these two species, which also are known from the *Eoaagnostus roddyi*-*Arthrocephalus chauveaui* Zone of Henson Gletscher Formation, North Greenland (Geyer & Peel, 2011). Thus, an accurate correlation between South China and North Greenland can be done.

ACKNOWLEDGEMENTS

This study was supported by the Ministry of Science and Technology of China (Grant No. 2015Fy310100), and the National Natural Science Foundation (Grant No. 41772021 to Yang, Zhao, Esteve; Grant No. 41662001 to Wu, Zhao). JE is also supported by FAPA (ID. PR. 3. 2018. 5527) from the Universidad de los Andes, Bogotá, Colombia.

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