

Eocene Planktonic Foraminifera and the Age of the Youngest Marine Sediments in Tūna, Yadong, Southern Tibet



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1 Introduction

The collision evolution between the Indian plate and the Eurasian plate is one of the significant geological events since the Mesozoic. It has profoundly influenced the global tectonic framework and led to the formation of the Qinghai-Tibet Plateau, which has attracted extensive attention of global geologists and become a research hotspot (Butler, 1995; Li and Wan, 2003a and b; Wang et al., 2003; Aitchison et al., 2007). However, there is still no consensus on the starting time of collision. The main reason for this is that scientists have different understandings of the initial time of collision and the methods used to determine the initial time are also different (Li and Wan, 2003a; Wang et al., 2003; Aitchison et al., 2007). A Cretaceous-Paleogene marine stratigraphic sequence in southern Tibet, which contains abundant microfossils (Wan, 1990; Willems and Zhang, 1993; Ding, 2003; Li and Wan, 2003a and b; Li et al., 2003, 2005a and b, 2007, 2009, 2011a and b; Niu et al., 2016; Wang et al., 2017; Zhang and Li, 2017) can provide a direct constraint on the age of the Neo-Tethyan Ocean (Ding, 2003; Li and Wan, 2003a and b; Li et al., 2003, 2005a and b; Jiang et al., 2015).

2 Materials and methods

The Gulupu section is located ~2km west of the town of Tūna, southern Tibet, which was interpreted as being deposited on the Greater Indian passive continental margin. The Zhepure Formation of this section is mainly composed of microfossil-bearing shale and limestone (Niu et al., 2016; Zhang and Li, 2017), which represented the southern Tethyan passive margin succession. Building the chronology required to calculate the rates of changes is a challenge in studying the evolution of the organisms in any given period of geological history. 154 samples were taken for study on the planktonic foraminiferal biostratigraphy of the Sandy-shale Member of the Zhepure Formation in the Gulupu section. The extraction and identification of the planktonic foraminifera were carried out in the Micropalaeontology Laboratory of the China University of Geosciences (Beijing). To free the radiolarians from the rocks

(mainly shale), the following procedures were followed. Samples were broken into the pieces with the particle size of 0.6–1 cm and placed in beakers. A diluted (10–15%) anhydrous sodium sulfate solution was added to cover the rocks for about two weeks. The samples were wet sieved using 20 and 250 mesh sieves and the residual samples were dried and examined. Representatives of each species were measured, gold-coated and imaged using a Scanning Electron Microscope (SEM).

3 Planktic foraminiferal biostratigraphy

Detailed study has been carried out on the planktonic foraminiferal biostratigraphy of the Sandy-shale Member of the Zhepure Formation in the Gulupu section and 119 species of 24 foraminiferal genera were identified, the important elements (Fig.1) of which include *Acarinina bullbrooki*, *A. broedermanni*, *A. pentacamerata*, *A. punctocarinata*, *A. soldadoensis*, *A. spinuloinflata*, *A. strabocella*, *A. wilcoxensis*, *Chiloguembelina cubensis*, *C. parallela*, *Cribrohantkenina inflata*, *Dentoglobigerina galavisi*, *Globigerina daubjergensis*, *G. eocaena*, *G. fringe*, *G. hagni*, *G. lozanoi*, *G. soldadoensis*, *G. triloculinoides*, *Globigerinatheka semiinvoluta*, *G. subconglobata subconglobata*, *Gumbelina midwayensis*, *Hantkenia nuttalli*, *Hastigerina bolivariana*, *Morozovella acuta*, *M. aequa*, *M. angulata*, *M. aragonensis*, *M. caucasus*, *M. formosa formosa*, *M. gracilis*, *M. lehneri*, *M. lensiformis*, *M. marginodentata*, *M. spinulosa*, *M. subbotinae*, *M. uncinata*, *M. velascoensis*, *M. trinidadensis*, *Planoglobanomalina pseudoalgeriana*, *Paragloborotalia griffinoides*, *Pseudoglobigerinella bolivariana*, *P. micra*, *P. naguewichiensis*, *P. pseudoscitula*, *Subbotina eocaena*, *S. patagonica*, *S. senni*, *S. triangularis*, *S. triloculinoides*, *Truncorotaloides rohri* and *T. boweri*.

Based on the analysis and summary of the planktic foraminifera, this paper preliminarily establishes a high-precision planktic foraminifera biostratigraphy of the Eocene in Gulupu, Yadong, southern Tibet. The Paleogene planktic foraminiferal biostratigraphy mainly established by Bolli et al. (1985) was used as a comparison. Seven planktonic foraminiferal biozones were recognized as follows (in ascending order):

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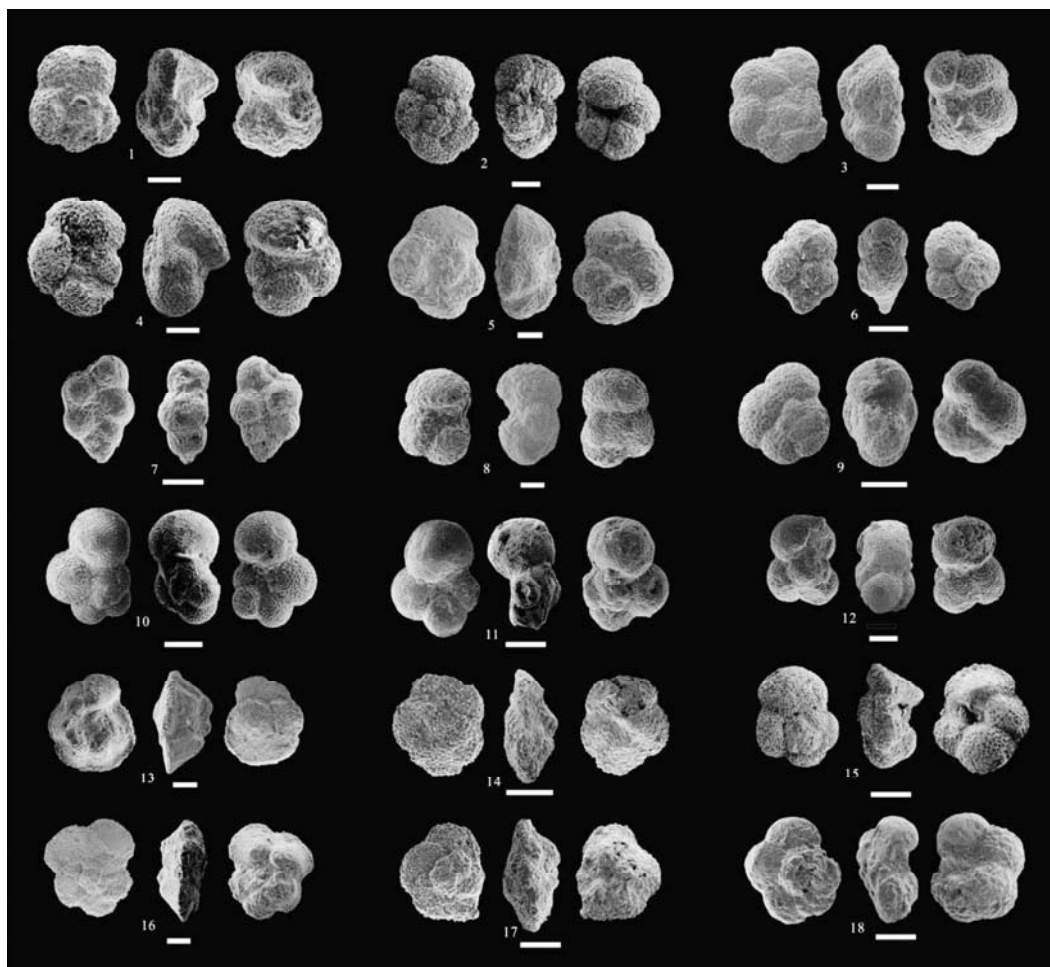


Fig. 1. Scanning electron micrographs of Eocene foraminifers in the Gulupu section.

1. *Acarinina bullbrooki* Fleisher; 2. *Acarinina esnaensis* (Nakkady); 3. *Acarinina pentacamerata* (subbotina); 4. *Acarinina pseudotopilensis* subbotina; 5. *Acarinina wilcoxensis* (Cushman & Ponton); 6. *Chilogumbelina crinita* (Glaessner); 7. *Chilogumbelina wilcoxensis* (Cushman & Ponton); 8. *Dentoglobigerina galavisi* (Bermúdez); 9. *Globigerina hagni* Gohrbandt; 10. *Globigerina inaequispira* subbotina; 11. *Globigerina officinalis* subbotina; 12. *Globigerina eocaena* Guembel; 13. *Morozovella aragonensis* (Nuttall); 14. *Morozovella gracilis* (Bolli); 15. *Morozovella lensiformis* (subbotina); 16. *Morozovella marginodentata* (subbotina); 17. *Morozovella spinulosa* (Cushman); 18. *Morozovella trinidadensis* (Bolli). Scale bar=100μm.

3.1 *Morozovella formosa formosa* Zone

The important elements of this zone are *Acarinina pentacamerata*, *A. primitiva*, *A. soldadoensis soldadoensis*, *Morozovella aragonensis*, *M. lensiformis*, *M. formosa formosa*, *M. marginodentata* and *Pseudohastigerina micra* etc. The age of this zone is middle Ypresian.

3.2 *Morozovella aragonensis* Zone

The representative elements of this zone are *Acarinina pentacamerata*, *Morozovella aragonensis*, *M. formosa formosa*, *M. subbotinae* and *T. cerroazuensis frontosa* etc. The age of this zone is late Ypresian.

3.3 *Acarinina pentacamerata* Zone

The important elements of this zone are *Acarinina pentacamerata*, *Morozovella aragonensis*, *M. quetra*, *Pseudohastigerina wilcoxensis*, *Turborotlia boweri*, *T. cerroazuensis frontosa*, *T. praecentralis* and *T. libyaensis* etc. The age of this zone is latest Ypresian.

3.4 *Hantkenia nuttalli* Zone

The important elements of this zone are *Acarinina bullbrooki*, *A. spinuloinflata*, *M. aragonensis*, *M. lehneri*, *M. spinulosa*, *Globigerina eocaena* and *G. senni* etc. The age of this zone is Lutetian - early Bartonian.

3.5 *Globigerinatheka subconglobata subconglobata* Zone

The important elements of this zone are *Acarinina bullbrooki*, *A. crassata*, *A. primitiva*, *A. pseudotopilensis*, *A. strabocella*, *Chilogumbelina ototara*, *C. trinitatensis*, *Globigerina eocaena*, *Globigerina officinalis*, *Globigerinatheka senni*, *M. spinulosa*, *Planorotalites pseudoscitula*, *T. boweri* and *T. cerroazuensis cerroazuensis* etc. The age of this zone is likely early Bartonian.

3.6 *Morozovella spinulosa*–*Acarinina bullbrooki* Zone

The important elements of this zone are *Morozovella lehneri*, *M. spinulosa*, *Pseudohastigerina micra*, *T. boweri*, *T. cerroazuensis cerroazuensis* and *T. cerroazuensis cocoaensis* etc. The age of this zone is middle Bartonian.

3.7 *Globigerinatheka semiinvoluta* Zone

The important elements of this zone are *Chilogumbelina*

wilcoxensis, *Dentoglobigerina galavisi*, *Pseudohastigerina micra*, *P. naguiewichensis*, *Turborotlia boweri*, *T. cerroazulensis*, *T. cerroazulensis coccaensis* etc. The age of this zone is roughly early - middle Priabonian.

4 Conclusions

The Zhepure Formation records a diverse, abundant, well-preserved planktic foraminiferal fauna that can be assigned to seven Eocene planktic foraminiferal zones, including *M. formosa formosa*, *M. aragonensis*, *A. pentacamerata*, *H. nuttalli*, *G. subconglobata subconglobata*, *M. spinulosa*–*A. bullbrookii* and *G. seminvoluta* zones.

The planktonic foraminiferal assemblage from the Sandy-shale Member of the Zhepure Formation gives it an early to late Eocene age, which indicates the final closure of the Tethys seaway should occur in the late Eocene or later in Tūna area.

Key words: Eocene, Yadong, Zhepure Formation, Tethyan Ocean, planktonic foraminifera

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