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滇西保山和腾冲地区二叠纪珊瑚及其古地理意义

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摘　要：基默里大陆在二叠纪时位于冈瓦纳大陆和欧亚大陆之间，由一系列大陆碎片或地块组成，包含掸泰马地块、腾冲地块、保山地块、拉萨地块、南羌塘、阿富汗南部和伊朗南部等地区．保山和腾冲地块作为基默里大陆的重要组成部分，在早二叠世时从地处冈瓦纳大陆的北缘裂解，并在中二叠世-晚二叠世向北漂移，这种特殊的古纬度变化导致保山和腾冲地块在下、中二叠统分别产出可能指示冷水和暖水的浅水水域环境的 *Cyathaxonia* 动物群和大型单体及复体四射珊瑚．中二叠世两个地块暖水型单体和复体珊瑚共有属种少，说明两者在古地理上并不相近．与中二叠世正处于低纬度地区的华南地块中极高的四射珊瑚生物多样性相比，保山和腾冲地块较低的四射珊瑚多样性，反映了两个地块在中二叠世时仍未到达温暖的低纬度地区．

关键词：四射珊瑚，二叠纪，基默里大陆，古生物地理
中图分类号：Q911　　　　**文献标志码**：A

Permian corals in the Baoshan and Tengchong blocks of western Yunnan and their paleogeographical implications

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Abstract: The Cimmerian Continent is composed of several allochthonous blocks, including the Shan-Thai, Tengchong, Baoshan, Lhasa, southern Qiangtang, southern Afghanistan, and southern Iran blocks. It was located between the Gondwanan and Eurasian continents during the Permian Period. The Baoshan and Tengchong blocks, as ones of the important parts of the Cimmerian Continent, splitted from the northern margin of Gondwana in the Early Permian, then drifted northward during the Middle Permian-Late Permian. This special latitudinal shift resulted in the occurrence of the cold shallow-water *Cyathaxonia* assemblage, and warm shallow-water large solitary and compound rugose corals in the Lower and Middle Permian respectively from these two blocks. The Middle Permian yields *Iranophyllum* sp., *Pavastehphyllum* sp., *Thomasiphyllum* cf. *spongifolium*, *Wentzelloides* sp., *Naoticophyllum* sp., *Wentzellophyllum persicum*, in the Baoshan Block, and *Lonsdaleiastraea* sp. A, *Lonsdaleiastraea* sp. B, *Wentzelellites* sp., *Thomasiphyllum tengchongense*, *Waagenophyllum kueichowense* in the Tengchong Block. Only a same genus *Thomasiphyllum* developed in the Middle Permian of these two blocks, which is also widely developed in the Middle Permian of the Cimmerian Continent. Only few co-occurrence of coral taxa between the Baoshan and Tengchong blocks may indicate that the two blocks are not close during the Middle Permian. Compared with the high diversity of rugose corals in the low-latitude South China Block during the Middle Permian, much lower diversity of rugose corals occurred in the Baoshan and Tengchong blocks, which implies that these two blocks could have not reached at warm, low latitude during this time.

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Key words: rugose coral, Permian, the Cimmerian Continent, paleobiogeography

云南西部的保山和腾冲地块在晚古生代属于基默里大陆(the Cimmerian Continent)的一部分,其二叠系由一套特殊的沉积序列组成.最底部的保山的丁家寨组和腾冲的空树河组产出具有指示冷水型及典型的冈瓦纳型的生物群[1−3],底部还发育冈瓦纳冰川成因的冰海相沉积物[3−6],指示保山和腾冲地块在早二叠世地处冈瓦纳大陆北缘或在其附近[7−10].保山和腾冲中二叠统-上二叠统中产出指示温水型的特提斯和基默里型的混生蜓类动物群[11−15],华夏型和冈瓦纳周缘型混生腕足类动物群[16],包含基默里大陆特有的珊瑚 *Thomasiphyllum*,蜓类 *Eopolydiexodina* 和非蜓类有孔虫 *Shanita*-*Hemigordiopsis* 动物群[17],它们的产出可指示保山和腾冲地块是基默里大陆的重要组成部分[18−19].

包括保山和腾冲的一系列地块所组成的基默里大陆在二叠纪从冈瓦纳大陆的北缘裂离出来,并向北漂移[8,11,18,20].这一过程导致基默里大陆与冈瓦纳大陆之间新特提斯洋的开启和扩张,并伴随着古特提斯洋的衰减与消亡[21−22].运用古生物化石恢复古地理是古生物地理学的主要内容,针对基默里各地块的二叠系特殊生物群进行分析,推断基默里各地块在二叠纪的古纬度变化是现今用于恢复基默里大陆古地理位置常用的方法[10−11,18,20],但是基默里各地块在二叠纪漂移的顺序及间隔的距离依旧存在争议.

本文尝试用四射珊瑚化石来讨论保山和腾冲地块之间的地层对比及它们在二叠纪的古地理位置.主要依据是,含鳞板带的大型单体珊瑚和复体珊瑚因其特殊的生活习性和对环境的高敏感性,指示低纬度浅水及温暖环境,可用于恢复古环境和古地理.但小型单体珊瑚的生态很广,故而缺乏狭义的古生物地理学意义,但特殊地区出现的珊瑚含边缘厚结带,也可用于指示冷水环境[23−24].本文的研究标本共78件,主要采自保山地块的北部区和南部区以及腾冲地块的北部区.

1　地层概况

1.1　保山地块的二叠系　保山地块的东边以北澜沧江-柯街-南汀河断裂为界,西边以怒江-龙陵-潞西断裂为界[25](图1).在保山地块内部根据地层发育情况可进一步识别出三个小区:北部区、南部区及西南区[4],其中以北部区二叠系发育最好,是研究的主要地区.北部区二叠系从下到上依次包含丁家寨组、卧牛寺组、丙麻组和大凹子组.

丁家寨组在代表剖面施甸东山坡上厚约120 m,主要由砂岩、粉砂岩和页岩组成,顶部夹数层生物碎屑灰岩,为海进沉积层序[26].丁家寨组底部到顶部所产的腕足类指示地层年代可能为阿瑟尔阶-亚丁斯克阶[1],与下伏的维宪阶云瑞街组之间为平行不整合或轻微的角度不整合接触,缺失上石炭统[18].上石炭统的海相沉积缺失也可见于腾冲、缅甸掸邦、拉萨、南羌塘、阿富汗南部和伊朗南部等基默里地块中,也是澳大利亚、印度和巴基斯坦等地区晚古生代的主要特征,这个长时间的地层缺失很可能与澳大利亚中部和北部、印度和南美的纳缪尔期隆升作用有关[27],或与石炭纪冈瓦纳冰川扩张有关,同时也可以成为指示基默里大陆曾位于冈瓦纳大陆北缘的重要证据之一[18].丁家寨组下部为硅质碎屑岩,含分选性差的角砾,它很可能代表冰川成因的杂砾岩,但在南部区丁家寨组底部却少有发育[4−5].丁家寨组产出的生物为典型的冷水型和冈瓦纳型[3,26,28−29].冰川成因的杂砾岩和亲冈瓦纳型生物的发现是确定保山地块在早二叠世位于冈瓦纳大陆北缘的重要证据[4,30−31].

卧牛寺组不整合于丁家寨组之上,命名剖面厚约700 m,由厚层玄武质熔岩夹凝灰岩组成,时代为亚丁斯克阶.卧牛寺组玄武岩被认为是大陆裂谷型的拉斑玄武岩,它的喷发标志着保山地块从冈瓦纳大陆分离的开端[6,32].在卧牛寺组之上沉积了一组杂色硅质碎屑岩,代表着继卧牛寺组玄武岩喷发之后重新接受沉积的开端,而杂色硅质碎屑岩与卧牛寺组玄武岩之间可能存在短期的

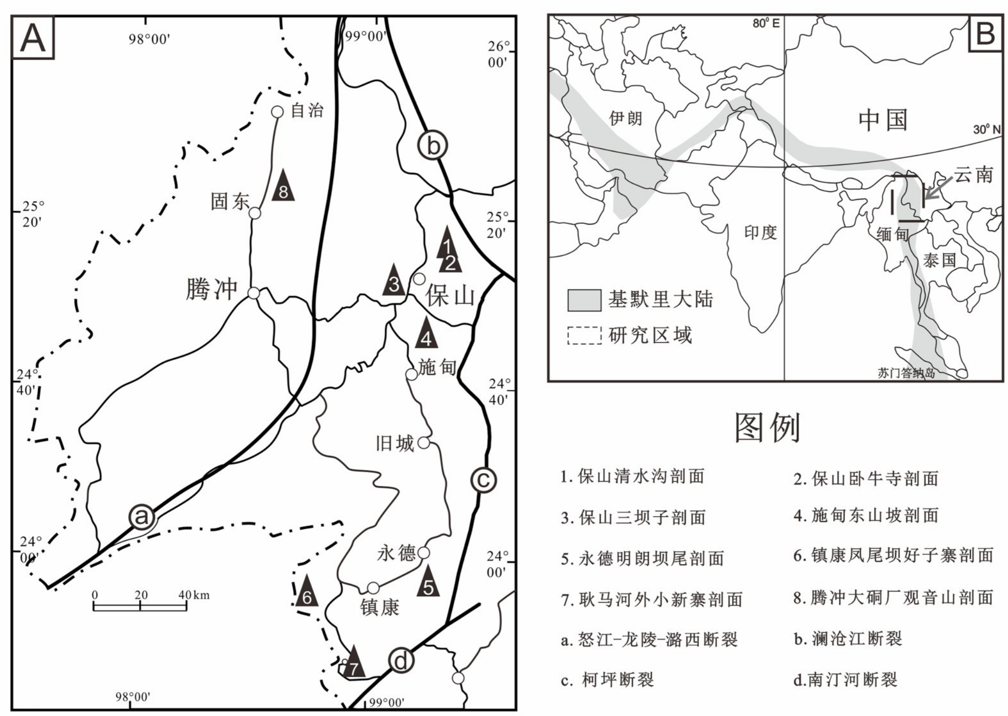

图 1 A:保山和腾冲地块地理及剖面位置图(据文献[9]);B:基默里大陆及研究区域位置图(据文献[18])

Fig. 1 A: Location of the studied sections in the Baoshan and Tengchong blocks (after ref. [9]), B: location of the Cimmerian Continent and the studied area (after ref. [18])

沉积间断[9,14].这组杂色硅质碎屑岩在保山北部区被命名为丙麻组,厚度小于 20 m,下部为硅质碎屑砾岩夹几层薄层熔岩,上部为粉砂岩和泥岩,未见化石[7-8,18].

覆在丙麻组之上的为大凹子组,下部为块状到厚层状泥质灰岩和生物碎屑颗粒岩,顶部为白云质灰岩和白云岩,在卧牛寺剖面上厚度大于 100 m,且与下伏的丙麻组碎屑岩似为整合接触[18].珊瑚、腕足类和蜓类主要产自于该组的下部,其中蜓类均为沃德期-卡匹顿期的蜓类[11-15].

南部区二叠系包含丁家寨组、卧牛寺组、永德组和沙子坡组.永德组首先由蓝朝华等(1983 年)命名,以取代云南省区域地质调查队(1960s)之前在保山地区命名的丙麻组或曼里组(未公开),命名剖面位于耿马河外小新寨剖面[4,16,33].永德组下部为粉砂岩、泥岩和砂岩组成,向上过渡为泥质灰岩、白云岩和白云质灰岩.永德组下部与北部区丙麻组对应,而上部的碳酸盐岩可与大凹子组的下部对应[14-15],很多学者将永德组代表南部区卧牛寺组和沙子坡组之间的一套沉积地层,并将永德组置于沙子坡组的下部[4,7,9,14-16],但也有学者认为永德组应仅限于下部的碎屑岩[11].

沙子坡组下部为泥质灰岩,上部为白云质灰岩及白云岩,为南部区二叠系最顶部的地层,厚超 600 m,底部边界不清[7],化石主要产自于沙子坡组的下部.

1.2 腾冲地块的二叠系 腾冲地块位于保山地块的西边,东边以怒江-龙陵-潞西断裂为界(图 1),而西边边界情况不明,很可能为缅甸八莫(Bahomo)到密支那(Myitkyina)一线[34].二叠系位于腾冲地块的中部,为从南到北的一条狭长条带,下部为硅质碎屑岩,上部为碳酸盐岩.其中下部的硅质碎屑岩在 1962 年被方仲景命名为勐洪群(未发表),命名地点位于腾冲市西南 20 km 的勐洪村[4].

腾冲地块按照地理位置被划分为北部区和南部区,其中北部区二叠系比南部区出露更好,研究程度也较高.北部区二叠系由下到上依次被划分为自治组、空树河组和大东厂组,前两者归属于勐洪群.南部地区二叠系由下到上依次被划分为邦

读组、罗梗地组、丝瓜坪组、大木场组和岩子坡组,除顶部的岩子坡组,其余均归属于勐洪群[4]. 本文的研究材料采集于腾冲北部区.

腾冲北部区自治组由厚约600～700 m的砂岩组成,由金小赤命名[4],命名地点位于腾冲市自治乡东边5～7 km的自治剖面,自治组下部未见底,未发现相关的化石报道,其下部可能延伸到格舍尔阶[18]. 在自治组之下存在未被命名的下石炭统地层,时代可能为杜内期-维宪期,与保山地区一样,存在大段的上石炭统的地层缺失.

空树河组总厚约800 m,下部为冰碛砾岩,中部为含砾泥岩,上部为泥岩和粉砂岩夹灰岩透镜体. 空树河组上部尤其是最顶部的100 m地层中产丰富的苔藓虫、腕足类和海百合茎,腕足类 *Notospirifer transversa*-*Elivina yunnanensis* 动物群为冷水型和亲冈瓦纳型生物群,年代为萨克马尔-早亚丁斯克期[9]. 空树河组下部的冰碛砾岩可与保山地区丁家寨组底部的冰碛砾岩进行对比[3],包括亲冈瓦纳型生物群的出现,成为了支持腾冲地块位于冈瓦纳北缘的重要证据. 因自治组缺失化石记录,推测自治组与空树河组共同组成的勐洪群的年代可能为格舍尔期晚期-亚丁斯克期[8,19].

大东厂组位于空树河组之上,厚约500 m,主要为灰岩和白云岩灰岩,向上白云岩逐渐变多,灰岩中含生物化石. 在大东厂组的下部和中部分别发现有晚萨克马尔期-亚丁斯克期的䗴类 *Eoparafusulina* 和 *Pseudofusulina*,沃德期-卡匹敦期的䗴类 *Chusenella*, *Monodiexodina*, *Yangchienia*, *Parafusulina* 等[35−36]. 在下部产小型单体无鳞板珊瑚 *Lophophyllidium*, *Verbeekiella*[8],在中部产丛状复体珊瑚 *Waagenophyllum kueichowense*,指示地层年代为中二叠统上部到上二叠统吴家坪阶. 因此,大东厂组地层时代很可能为是晚萨克马尔期-吴家坪期[18].

2　保山和腾冲地区二叠纪四射珊瑚

本文研究标本来自八条剖面,分别为施甸县由旺镇东山坡剖面、保山金鸡村清水沟剖面、保山金鸡村卧牛寺剖面、耿马县河外小新寨剖面、保山三坝子剖面、永德县明朗坝尾剖面、镇康凤尾坝好子寨剖面和腾冲明广大硐厂观音山剖面(图1). 本文研究了前辈学者采得的四射珊瑚标本78件,其中保山56件,腾冲22件. 其中丁家寨组的样品来自东山坡、清水沟、好子寨和三坝子剖面;大凹子组样品来自卧牛寺;永德组样品来自小新寨和坝尾剖面;沙子坡组样品来自坝尾剖面. 样品被磨制成珊瑚薄片199片,鉴定出15属18种.

采于丁家寨组顶部灰岩中的珊瑚,经鉴定包含 *Lophophyllidium* sp., *Naoticophyllum* sp., *Zaphrentites* sp., *Cyathaxonia* sp. 等,它们可与 Wang et al[37]曾报道的丁家寨组的小型单体珊瑚 *Zaphrentites shidianense*, *Claviphyllum baoshanense*, *Cyathaxonia* sp. 等(图2)归入小型无鳞板的单体珊瑚 *Cyathaxonia* 动物群中. *Cyathaxonia* 动物群最早由Hill[38−39]提出,经常伴随2～3种横板珊瑚的产出,出现在黑色钙质页岩、薄层泥质灰岩或富含海百合的灰岩中,它代表一种受基质、水深和温度等各种环境因素控制的特殊生物群[37]. 丁家寨组 *Cyathaxonia* 动物群可与出现在掸泰马地块下二叠统的小型单体珊瑚 *Paracaninia sinensis*, *Verbeekiella* sp., *Lophophyllidium siamense*, *Ufimia khaokaeonoi*, *Euryphyllum khaokaeoyai*, *Euryphyllum kanchanaburi* 等进行对比[11,32,40],并可与澳大利亚悉尼盆地南部二叠系小型单体珊瑚进行对比,这些小型单体珊瑚均可能产自于沉积环境为冰水或冷水的地层中[37].

在大凹子组下部采集到的珊瑚,包含单体珊瑚 *Pavastehphyllum* sp., *Thomasiphyllum* cf. *spongifolium*,复体珊瑚 *Wentzellophyllum persicum* 及横板珊瑚 *Sinopora asiatia*. 采集于小新寨剖面永德组上部灰岩中的珊瑚包含复体珊瑚 *Wentzelloides* sp., *Wentzellophyllum persicum*,单体珊瑚 *Thomasiphyllum* cf. *spongifolium*, *Ufimia* sp. 及横板珊瑚 *Sinopora asiatia* 等. 采集于保山南部永德组上部和沙子坡组下部的珊瑚包含单体珊瑚 *Iranophyllum* sp., *Pavastehphyllum* sp., *Thomasiphyllum* cf. *spongifolium*,复体珊瑚 *Naoticophyllum* sp. (图2和图4),其中 *Thomasiphyllum* 常见于基默里大陆中二叠统地层中[7],如印度尼西亚苏门答腊岛西部[41−42]、泰国半岛[43−44]、缅甸掸邦[45]、西藏中部[46−47]及南部伊朗[48−49]等地.

采集于腾冲地块的大硐厂观音山剖面的大东

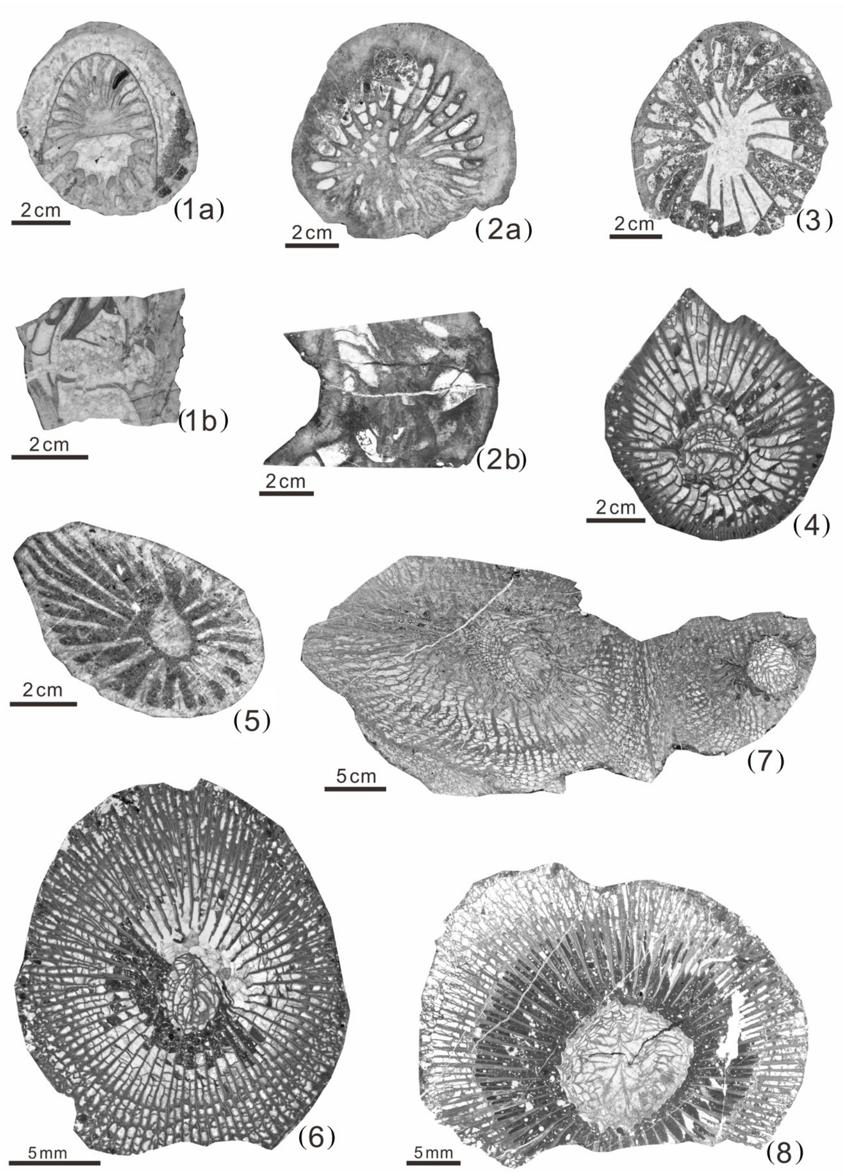

图 2 **(1)** ***Zaphrentites* sp.** ,保山三坝子剖面,丁家寨组:(1a)横切面,(1b)纵切面;(2) ***Cyathaxonia* sp.** ,施甸县由旺镇东山坡剖面,丁家寨组:(2a)横切面,(2b)纵切面;(3) ***Ufimia* sp.** ,耿马县河外小新寨剖面,永德组,横切面;(4) ***Pavastehphyllum* sp.** ,永德县明朗坝尾剖面,沙子坡组,横切面;(5) ***Lophophyllidium* sp.** ,镇康凤尾坝好子寨剖面,丁家寨组,横切面;(6) ***Iranophyllum* sp.** ,永德县明朗坝尾剖面,沙子坡组,横切面;(7) ***Naoticophyllum* sp.** ,永德县明朗坝尾剖面,沙子坡组,横切面;(8) ***Thomasiphyllum* cf. *spongifolium***,耿马县河外小新寨剖面,永德组,横切面

Fig. 2 (1) *Zaphrentites* sp. from the Dingjiazhai Formation in the Sanbazi section,Baoshan City , (1a) transverse section,(1b) longitudinal section,(2) *Cyathaxonia* sp. from the Dingjiazhai Formation in the Dongshanbo section,Youwang,Shidian County , (2a) transverse section,(2b) longitudinal section,(3) *Ufimia* sp. from the Yongde Formation in the Xiaoxinzhai Section,Gengma County,transverse section,(4) *Pavastehphyllum* sp. from the Shazipo Formation in the Bawei Section,Minglang,Yongde County,transverse section,(5) *Lophophyllidium* sp. from the Dingjiazhai Formation in the Haozizhai Section,Fengweiba,Zhankang County,transverse section,(6) *Iranophyllum* sp. from the Shazipo Formation in the Bawei Section,Minglang,Yongde County,transverse section,(7) *Naoticophyllum* sp. from the Shazipo Formation in the Bawei Section,Minglang,Yongde County,transverse section,(8) *Thomasiphyllum* cf. *spongifolium* from the Yongde Formation in the Xiaoxinzhai Section,Gengma County,transverse section

厂组灰岩中的珊瑚,经鉴定包含复体珊瑚 *Lonsdaleiastraea* sp. A,*Lonsdaleiastraea* sp. B,*Wentzelellites* sp.,*Waagenophyllum kueichowense*,单体珊瑚 *Thomasiphyllum tengchongense* 及横板珊瑚 *Sinopora xainzaensis*. *Waagenophyllum kueichowense* 常产自于中二叠统的上部到上二叠统底部[8],可指示大东厂组可能含中二叠世晚期到吴家坪期的地层(珊瑚产出层位见图3).

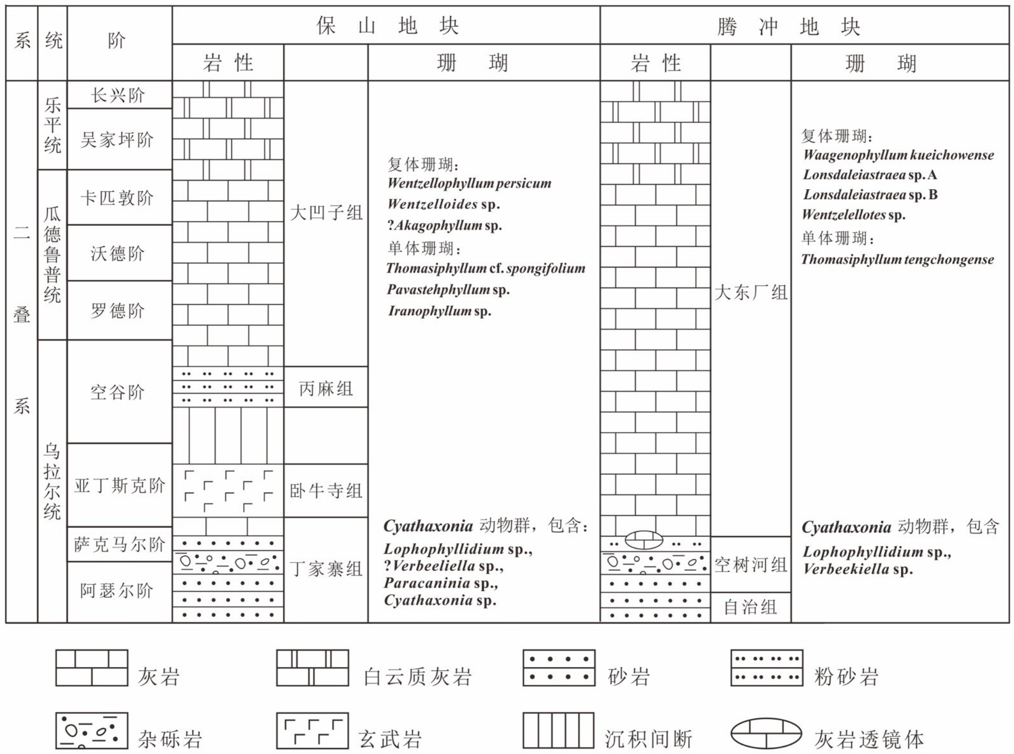

图3　保山和腾冲地块二叠纪珊瑚及其主要产出层位

Fig. 3　The Permian corals in the Baoshan and Tengchong blocks and their main coral-bearing levels

3　古地理意义的讨论和结论

受冈瓦纳冰川扩张的影响,位于冈瓦纳北缘的保山和腾冲地块在早二叠世分别在丁家寨组和空树河组中发育冰海成因的杂砾岩[3-4,6]. 伴随着冰室气候结束,萨克马尔期末全球发生大规模的海进事件[50],在丁家寨组碎屑岩和空树河组碎屑岩之上同时沉积萨克马尔期晚期-亚丁斯克期早期的呈透镜状或层状海百合茎灰岩,产小型无鳞板的单体 *Cyathaxonia* 动物群、窄适性温水的蜓类动物群、及冈瓦纳型腕足类. 指示了当时的保山和腾冲地块不可能位于水温很冷的高纬度地区,可能地处当时冈瓦纳的北缘,位于中纬度地区.

伴随着卧牛寺组玄武岩的喷发,保山地块在亚丁斯克期开始从冈瓦纳的北缘裂解并向北漂移,尽管腾冲地块并没有出现玄武岩,却能随基默里大陆一起向北漂移,可能与喜马拉雅造山运动产生的走滑断裂有关[6]. 保山地块和腾冲地块在向北漂移的过程中,均在沃德阶-卡匹敦阶/吴家坪阶底部产出具有指示水域温暖的低纬度地区的复体珊瑚和大型单体珊瑚. 它们的出现可能指示保山地块和腾冲地块古纬度相近,两个地块几乎在同一时期达到大型单体珊瑚及复体珊瑚的生活的低纬度地区.

保山地块发育的复体珊瑚及单体珊瑚为 *Iranophyllum* sp., *Pavastehphyllum* sp., *Thomasiphyllum* cf. *spongifolium*, *Wentzelloides* sp., *Naoticophyllum* sp., *Wentzellophyllum persicum* 等(见图3),而腾冲地块则产出 *Lonsdaleiastraea* sp. A, *Lonsdaleiastraea* sp. B, *Wentzelellites* sp, *Thomasiphyllum tengchongense*, *Waagenophyllum*

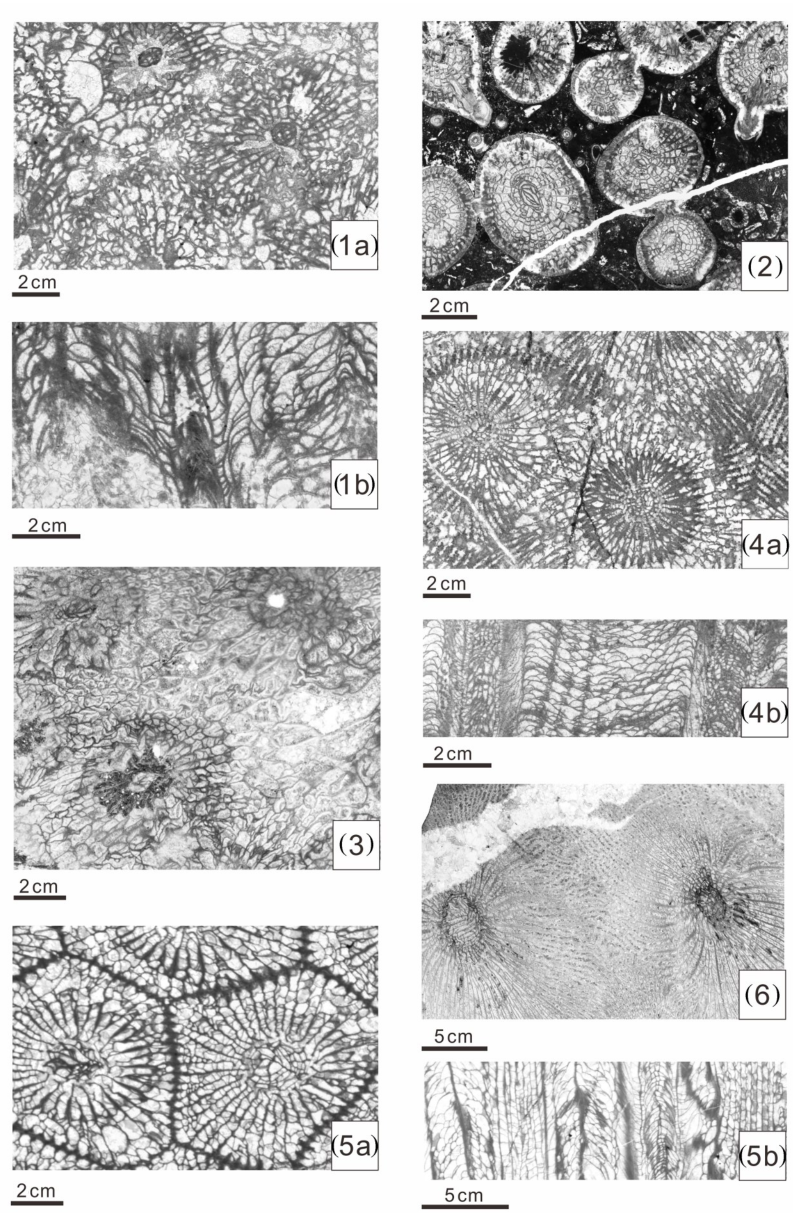

图 4 (1) *Lonsdaleiastrae* sp. A,腾冲大硐厂观音山剖面,大东厂组:(1a)横切面,(1b)纵切面;(2) *Waagenophyllum kueichowense*,腾冲大硐厂观音山剖面,大东厂组,横切面;(3) *Lonsdaleiastrae* sp. B,腾冲大硐厂观音山剖面,大东厂组,横切面;(4) *Wentzelloides* sp. ,耿马县河外小新寨剖面,永德组:(4a)横切面,(4b)纵切面;(5) *Wentzellophyllum persicum*,耿马县河外小新寨剖面,永德组:(5a)横切面,(5b)纵切面;(6) *Wentzelellites* sp. ,腾冲大硐厂观音山剖面,大东厂组,横切面

Fig. 4 (1) *Lonsdaleiastrae* sp. A from the Dadongchang Formation in the Guanyinshan Section,Dadongchang,Tengchong City: (1a) transverse section,(1b) longitudinal section,(2) *Waagenophyllum kueichowense* from the Dadongchang Formation in the Guanyinshan section,Dadongchang,Tengchong City,transverse section,(3) *Lonsdaleiastrae* sp. B from the Dadongchang Formation in the Guanyinshan section in Dadongchang,Tengchong City,transverse section,(4) *Wentzelloides* sp. from the Yongde Formation in the Xiaoxinzhai section,Gengma County: (4a) transverse section,(4b) longitudinal section, (5) *Wentzellophyllum persicum* from the Yongde Formation in the Xiaoxinzhai section,Gengma County: (5a) transverse section,(5b) longitudinal section,(6) *Wentzelellites* sp. from the Dadongchang Formation in the Guanyinshan section,Dadongchang,Tengchong City,transverse section

kueichowense 等,两个地块之间共有属较少,仅有 *Thomasiphyllum*,且共有属之间已经发生有因区域隔离产生种级的分化现象,潜在的种级分化及较少的共有属可能指示在中二叠世时期,保山和腾冲地块之间的珊瑚交流甚少,两个地块并不相邻,之间间隔一定的距离.另外,保山地块和腾冲地块相对于华南地区,其同时期的珊瑚生物多样性低得多,华南板块罗德期-沃德期含四射珊瑚 40 属,132 种,卡匹顿期含四射珊瑚 31 属,105 种[51].比较华南板块在中二叠世位于温暖的低纬度特提斯区,保山和腾冲地块较低的珊瑚生物多样性可能反映了此两个地块此时可能并未到达温暖的低纬度地区.

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