

贵州紫云地区呢罗段的牙形石及其时代意义*

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摘要 黔南地区中三叠统许满组(新苑组)上部发育一套黏土岩夹碳酸盐岩的海相沉积(呢罗段)。本研究对贵州紫云地区呢罗段开展剖面实测及采样, 在呢罗段及边阳组的碳酸盐岩中采获少量牙形石, 经鉴定为*Budurovignathus mungoensis*, *Paragondolella excelsa*, *Paragondolella inclinata*, *Gladigondolella* cf. *malayensis*, *Gladigondolella tethydis*, *Paragondolella* cf. *willistonensis*和*Quadralella* aff. *polygnathiformis*等重要属种。其中, *Budurovignathus mungoensis*系该区域除关刀剖面之外首次被发现。通过讨论牙形石组合及其分布时限, 结合前人的菊石材料, 认为呢罗段是中三叠世安尼期–拉丁期晚期的沉积产物。这一研究可为该区中三叠世的地层时代划分、区域对比及进一步了解南盘江盆地演化提供有意义的材料。

关键词 牙形石 呢罗段 三叠纪 贵州紫云

DOI: 10.3724/micropals-2026003

引 言

牙形石作为一种广泛分布于寒武纪至三叠纪海相碳酸盐岩地层的微体化石, 是全球地层划分和对比的重要标志。在三叠纪, 尤其是中–晚三叠世地层划分中, 牙形石扮演着非常重要的角色(Orchard, 2010; Rigo *et al.*, 2018)。当前, 中三叠世牙形石研究主要以西特提斯及北美地区为主(如: Huckriede, 1958; Mosher & Clark, 1965; Mosher, 1968; Kozur, 1972; Golding *et al.*, 2014; Golding & Orchard, 2016, 2018), 并且国际中三叠世牙形石生物地层格架是基于这些地区的牙形石带建立的(Ogg *et al.*, 2020), 而泛大洋西部和东特提斯的研究相对薄弱(Nogami, 1968; Metcalfe, 1990; Zhang *et al.*, 2019)。中国中三叠世牙形石研究从二十世纪七、八十年代就已经开始, 许多地方有中三叠世牙形石的报道, 如

西藏地区(田传荣, 1983; 武桂春等, 2007; Wu *et al.*, 2019, 2025; Li *et al.*, 2025), 贵州(王红梅等, 2005; Sun *et al.*, 2006; Ji *et al.*, 2011; Yan *et al.*, 2015; Liang *et al.*, 2016; Qin *et al.*, 2021), 四川的江油和北川(王志浩和戴进业, 1981)、松潘(饶荣标等, 1985), 广西平果太平(杨守仁等, 1986)、凤龙湾头及乐业幼平(Yan *et al.*, 2015; Chen *et al.*, 2020)、田东作登(Yan *et al.*, 2015), 以及滇东的罗平(Huang *et al.*, 2019)和滇西保山地区(王伟等, 2019; Qin *et al.*, 2026)。因受拉丁期大海退(殷鸿福, 1982)的影响, 中国多数地区缺失拉丁期的海相沉积, 中三叠世牙形石研究主要以安尼期为主, 仅在贵州、云南和西藏的少数剖面有拉丁期牙形石的报道(王红梅等, 2005; Li *et al.*, 2025; Qin *et al.*, 2026)。

贵州海相三叠系发育良好, 沉积类型多样, 化石丰富, 是中国研究三叠纪生物与环境协同演化的理

*广西自然科学基金项目(2026GXNSFAA00641070)、中国地质科学院岩溶地质研究所基本科研业务费(YRQN2025003)和中国地质调查局地质调查项目(DD202501029)共同资助。

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收稿日期 2026-02-09, 修改稿收到日期 2026-05-18

想场所之一。在中-晚三叠世时期,紫云地区处于深水斜坡-盆地环境。该区中-晚三叠世的地层自下而上包括许满组(新苑组)、边阳组、黑苗湾组和赖石科组。其中,在许满组(新苑组)顶部发育一套分布广泛、层位稳定、岩性特征明显的特殊岩性层——呢罗段,该岩性段主要以黏土岩为主,夹瘤状灰岩,但区域岩性变化明显,厚度约20~60 m(贵州省地质矿产局, 2017)。关于呢罗段的沉积时代,董卫平等(1997)认为呢罗段沉积仅限于中三叠世,是识别碎屑岩地层安尼阶与拉丁阶界线的关键标志层。根据最新版贵州省区域地质志(贵州省地质矿产局, 2017),在贞丰县新苑组呢罗段中发现菊石 *Balatonites*、*Paraceratites* 和 *Protrachyceras* 及双壳类 *Daonella*; 在罗甸县逢亨濠江一带的呢罗段中产牙形石 *Quadrallella* cf. *polygnathiformis*, 这些化石证据指示呢罗段为中三叠世安尼期-拉丁期的沉积。

笔者在贵州紫云地区从事1:5万区域地质调查工作期间,在四大寨乡附近发现一条地层连续、露头良好,顶底界线清晰的呢罗段——四大寨卡标村剖面。通过对剖面开展牙形石研究,在呢罗段捕获了拉丁期晚期的牙形石,这一发现为准确厘定呢罗段时代及进一步研究扬子台地西南缘地层层序、时代划分及盆地演化提供有意义的资料。

1 地质背景及研究剖面

研究剖面位于贵州省安顺市紫云县四大寨乡西南约2.5 km的公路旁,剖面坐标E106°09'09", N25°

34'09"(图1)。该剖面位于南盘江盆地西北缘,大地构造上隶属右江地层分区下的紫云-都匀小区,属于斜坡-盆地相沉积环境。剖面出露地层自下而上依次为许满组、呢罗段、边阳组,其中许满组和边阳组以碎屑岩沉积为主,偶夹碳酸盐岩;呢罗段则主要为瘤状灰岩、泥晶灰岩夹泥岩,中部夹两层斑脱岩,含双壳类等化石。具体岩性描述如下:

边阳组

未见顶。

9. 灰色中层至块状砾屑灰岩。5.1 m处KBC-8产 *Budurovignathus mungoensis* (Diebel, 1956), *Gladigondolella tethydis* (Huckriede, 1958), *Quadralella* aff. *polygnathiformis* (Budurov & Stefanov, 1965), *Gladigondolella* sp. 和鱼牙。厚10.9 m

8. 灰色厚层至块状含砾钙质粉细砂岩,在中部夹一层泥晶灰岩。2.5 m处KBC-7产 *Paragondolella inclinata* (Kovács, 1983), *Gladigondolella* cf. *malayensis* Nogami, 1968, *Gladigondolella tethydis*, *Paragondolella* sp. 和鱼牙。厚11.1 m

7. 灰色中至厚层状钙质粉砂岩与泥质粉砂岩不等厚互层。厚6.3 m

——整合——

呢罗段

6. 灰色中层状微晶灰岩与中-厚层状生物屑灰岩不等厚互层。1.9 m处KBC-6产 *Paragondolella excelsa* Mosher, 1968, *Paragondolella inclinata*, *Paragondolella* cf. *willistonensis* Orchard, 2007 和 *Quadralella* aff. *polygnathiformis*。厚5.0 m

5. 灰色薄-中层状泥晶灰岩与瘤状灰岩互层,往上灰岩减少,为灰绿色薄层状泥岩,含双壳类。0.25 m处KBC-5产 *Paragondolella excelsa*, *Paragondolella inclinata* 和 *Paragon-*

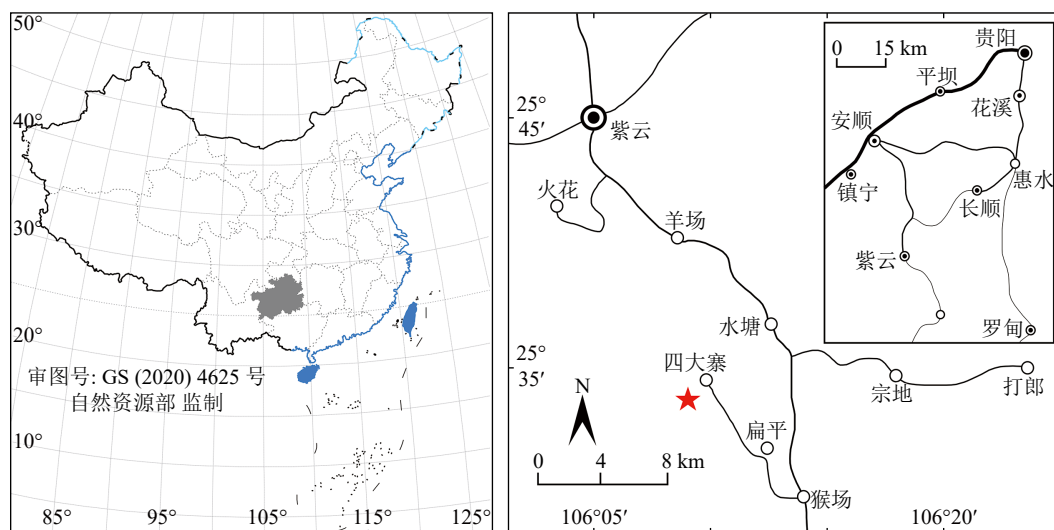


图1 研究剖面(红星)地理位置图(底图分别来自<http://bzdt.ch.mnr.gov.cn/index.html>和<https://map.360.cn>)

Fig. 1 Sketched location of the study section (red star) (the base maps are from <http://bzdt.ch.mnr.gov.cn/index.html> and <https://map.360.cn>, respectively)

dolella sp.。厚2.1 m

4. 底部为一套灰色薄层泥晶灰岩, 中部为瘤状灰岩, 往上灰岩减少, 上部为灰绿色薄层状泥岩, 含双壳类, 顶部为一层厚约2 cm的斑脱岩。0.5 m处采样KBC-4。厚1.6 m

3. 灰色薄-中层状泥晶灰岩与瘤状灰岩互层, 往上瘤状灰岩减少, 在中上部夹一层厚约30 cm的斑脱岩。0.6 m处采样KBC-3。厚5.9 m

2. 底部为一套薄层状钙质泥岩, 往上为薄-中层状泥晶灰岩夹生物屑灰岩。1.5 m处采样KBC-2。厚5.5 m

———整合———

许满组

1. 灰色薄至中层状泥质灰岩夹薄层状泥岩, 由下往上构成泥灰岩-泥岩的旋回。1.5 m处采样KBC-1。厚1.7 m

未见底

2 牙形石动物群及其时代讨论

本次在卡标村剖面采集了8件牙形石样品, 经处理, 其中4件样品产牙形石(图2), 但丰度和多样性均较低, 共识别出*Budurovignathus*, *Gladigondolella*, *Paragondolella*和*Quadralella*属(表1, 图3)。保存完整的牙形石可为地层时代的厘定提供可靠依据, 然而本剖面主要以碎屑岩为主, 灰岩较少, 野外采样间距较大, 牙形石产出数量有限且保存较差。在所获牙形石分子中, 可用于建带的分子(如:*Budurovignathus mungoensis*, *Paragondolella excelsa*, *Paragondolella inclinata*和*Quadralella* aff. *polygnathiformis*)在地层中的延续情况无法确认, 因此无法建立可靠的牙形石带。当前仅能依靠单个样品中所

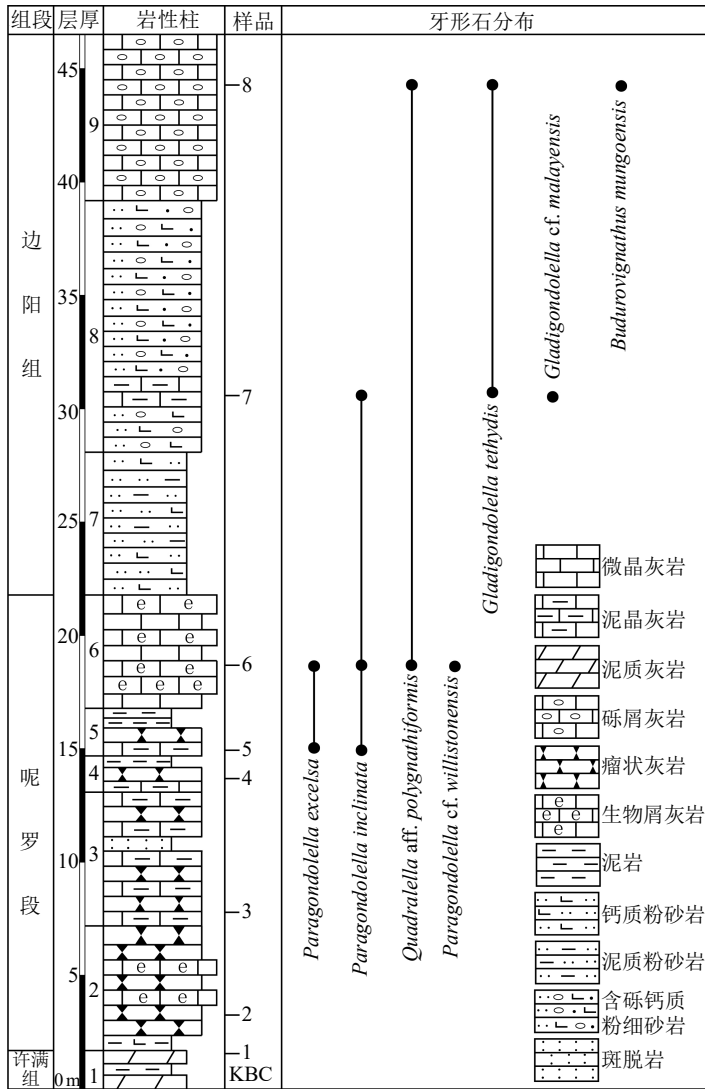


图2 贵州紫云卡标村剖面岩性柱状图及牙形石分布延限

Fig. 2 Integrated lithostratigraphic column and the distribution of conodonts at the Kabiaocun section, Ziyun, Guizhou Province

表1 卡标村剖面牙形石统计表

Table 1 Distribution of the conodonts at the Kabiaocun section

样品号	<i>Budurovignathus</i>	<i>Gladigondolella</i>	<i>Paragondolella</i>	<i>Quadralella</i>
KBC-8	1	3	\	1
KBC-7	\	5	3	\
KBC-6	\	\	3	1
KBC-5	\	\	4	\

获牙形石属种组合, 与国际标准牙形石带进行对比, 从而大致确定地层时代。

*Paragondolella willistonensis*最早由 Orchard (2007)报道于加拿大不列颠哥伦比亚省东北部, 随后, 在美国内华达新帕斯山脉地区的拉丁阶-卡尼阶界线附近也有该分子的报道 (Orchard & Balini, 2007)。该种的主要特征是具有双凸的前齿台和狭窄球状的后齿台, 主齿前部明显收缩。在北美, *Pg. willistonensis*通常与菊石 *Frankites* 和 *Daxatina* 共生, 是 *Quadralella intermedius* 带和 *Q. tadpole* 带的常见分子, 指示拉丁期晚期-卡尼期早期 (Orchard, 2007, 2010)。Chen 等 (2016) 认为 *Pg. willistonensis* 的分布仅限于卡尼期 Julian 早期。本次研究在呢罗段上部 (KBC-6) 采获一枚特征与 *Pg. willistonensis* 相似的幼年分子 (图3-3), 暂定为 *Pg. cf. willistonensis*。

Paragondolella excelsa 具有全球性分布特征, 最早出现在安尼阶 Reitzites 菊石带内, 是安尼阶-拉丁阶界线附近常见的牙形石种 (Brack et al., 2005; Orchard, 2010), 以该种建立的 *Pg. excelsa* 带通常被当作安尼阶最顶部的牙形石带 (Orchard & Tozer, 1997; Lehrmann et al., 2015), 或拉丁阶的第一个牙形石带 (王成源, 1991)。在中国, 童金南等 (2019) 认为可以将 *Pg. excelsa* 的首现作为新铺阶的底界。该种分布时限从安尼阶 Illyrian 亚阶下部至拉丁阶 Fassanian 亚阶上部 (Orchard, 2010; Chen et al., 2016)。

Paragondolella inclinata (Kovács, 1983) 是中-晚三叠世之交常见的牙形石种, 具有全球广泛分布的特征, 分布时代从拉丁期 Longobardian 早期一直延续到卡尼期 Julian 晚期 (Rigo et al., 2007; Chen et al., 2017; Maron et al., 2019; 覃斌贤等, 2023)。以该种建立的 *Pg. inclinata* 带常被视为是拉丁阶最顶部的一个牙形石带, 或作为卡尼阶最底部 *Pg. inclinata*-*Mosherella* 组合带的特征分子 (Orchard & Tozer, 1997; Lehrmann et al., 2015; 王成源和郎嘉彬, 2019)。

Quadralella polygnathiformis 被认为是由 *Paragondolella inclinata* 演化而来 (Kovács, 1983; Mazza

et al., 2010)。该种具有全球性的分布特征, 广泛报道于欧洲 (Mietto et al., 2007, 2012; Muttoni et al., 2014), 北美 (Orchard, 2007; Orchard & Balini, 2007), 东南亚 (Metcalf, 1990, 1992), 印度 spiti 地区 (Balini et al., 1998; Bhargava et al., 2004; Krystyn et al., 2004) 以及中国的华南 (王红梅等, 2005; Zhang et al., 2017; 江海水等, 2018; 覃斌贤等, 2023)、西藏 (武桂春等, 2007; Wu et al., 2024; Li et al., 2025) 等地区。Budurov 和 Stefanov (1965) 在建立 *Q. polygnathiformis* 时, 仅提供了侧视图和反口视图, 缺少口视图的正模原始插图, 并且原始定义也不充分。Orchard 和 Balini (2007) 及江海水等 (2018) 从齿台轮廓、齿脊形态、主齿特征等重新严格限定了 *Q. polygnathiformis* 的鉴定特征, 认为侧齿台前部一侧或两侧明显膝状弯曲是该种的主要鉴定特征。尽管以 *Q. polygnathiformis* 的首现 (First Occurrence) 作为全球海相拉丁阶-卡尼阶界线 (Ladinian-Carnian Boundary) 的辅助标志已被广泛认可 (Balini et al., 2000; Kozur, 2003; Muttoni et al., 2004; 孙作玉等, 2005; Mietto et al., 2007, 2012; Lehrmann et al., 2015; 江海水等, 2018), 但因该牙形石的首现与作为界线首要标志的菊石 *Daxatina canadensis* 的首现 (First Appearance Datum) 不等时 (Orchard, 2010; Mietto et al., 2012), 在喜马拉雅山南部 Spiti 地区、欧洲阿尔卑斯地区及北美, *Q. polygnathiformis* 甚至与拉丁期菊石共生 (Mosher, 1973; Krystyn et al., 1980, 2004; Balini et al., 1998; Orchard, 2010)。因此, 以该分子首现作为标志划分拉丁阶-卡尼阶界线逐渐受到质疑 (Krystyn et al., 2004; Orchard & Balini, 2007; Orchard, 2010)。据现有资料, *Q. polygnathiformis* 地层分布时限从拉丁期晚期至卡尼期 Tuvanian 亚期 (Gallet et al., 1998; Orchard, 2010; Chen et al., 2016; Rigo et al., 2018)。本研究分别在呢罗段上部生物屑灰岩 (KBC-6) 和边阳组下部泥晶灰岩 (KBC-8) 采获两枚与 *Q. polygnathiformis* 具相似特征的标本 (图3-2, 8), 但因侧齿台前部无明显膝状弯曲, 暂定为 *Quadralella aff. polygnathiformis*。

Gladigondolella 是一个广泛分布于特提斯和泛大洋部分区域、地层延限很长的牙形石属, 在北美和高纬度地区则鲜有报道 (Kozur et al., 2009; Chen et al., 2016)。在西特提斯地区, *Gladigondolella* 主要报道于拉丁期至卡尼期, 其灭绝常被作为卡尼阶 Julian-Tuvanian 亚阶界线的标志之一 (Kozur, 1989, 2003)。在中国, *Gladigondolella* 分布异常有限, 目前仅报道于贵州和西藏的少数剖面 (武桂春等, 2007; Sun et al., 2016; 张再天等, 2018; Qin et al., 2021; 覃

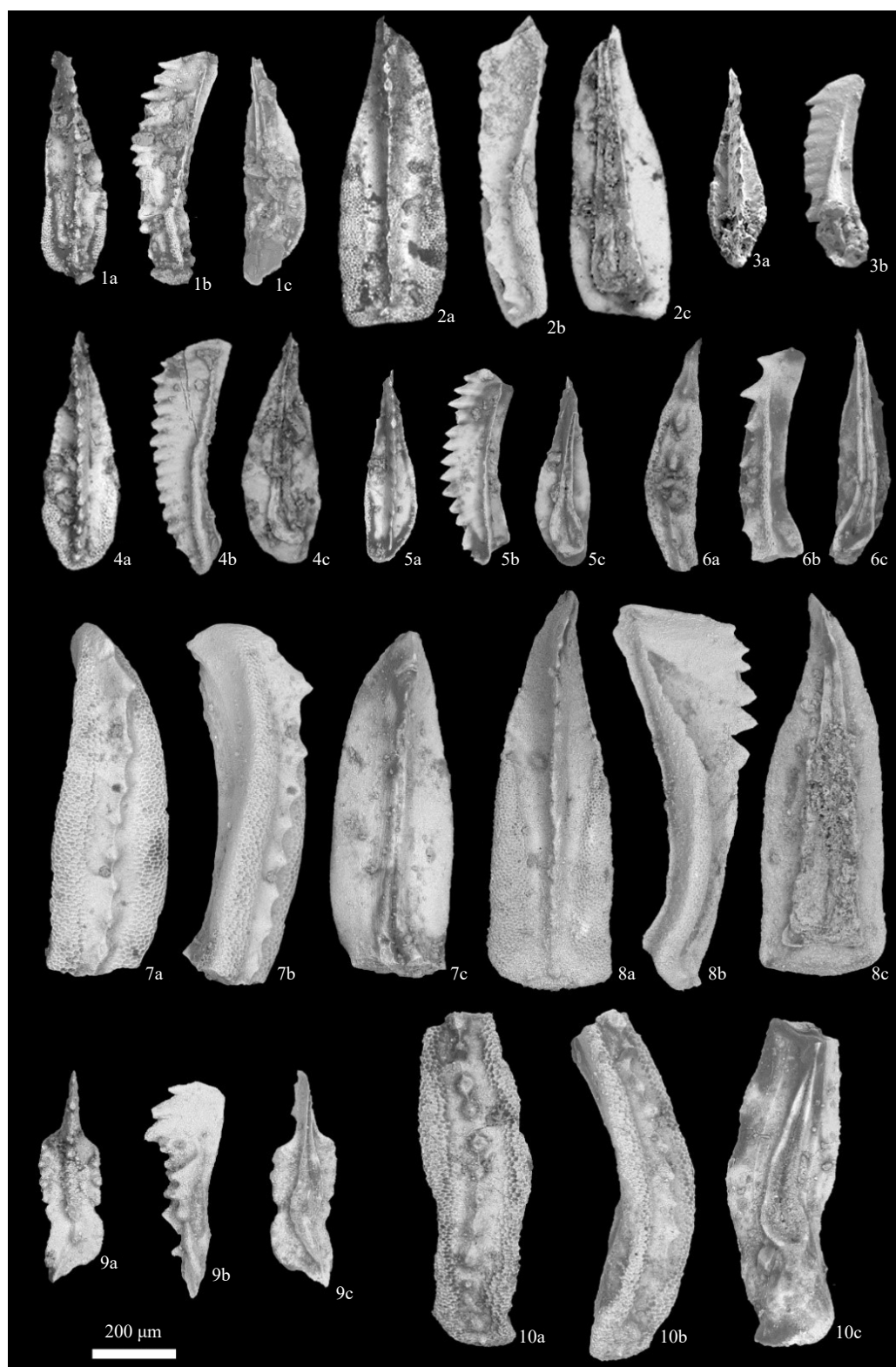


图3 贵州紫云卡标村剖面牙形石扫描电镜照片

Fig. 3 Scanning Electron Microscope (SEM) photographs of conodonts at the Kabiaocun section, Ziyun, Guizhou Province

1, 5. *Paragondolella excelsa* Mosher, 1968: 1. KBC-5_003; 5. KBC-6_005; 2, 8. *Quadralella* aff. *polygnathiformis* (Budurov et Stefanov, 1965): 2. KBC-6_004; 8. KBC-8_006; 3. *Paragondolella* cf. *willistonensis* Orchard, 2007: KBC-6_001; 4. *Paragondolella inclinata* (Kovács, 1983), KBC-6_002; 6, 7. *Gladigondolella* cf. *malayensis* Nogami, 1968: 6. KBC-7_001; 7. KBC-7_002; 9. *Budurovignathus mungoensis* (Diebel, 1956), KBC-8_007; 10. *Gladigondolella tethydis* (Huckriede, 1958), KBC-8_009; 图中a为口视, b为侧视, c为反口视

斌贤等, 2023)。 *Gl. tethydis* (Huckriede, 1958) 是由 *Gl. carinata* (Bender, 1970) 演化而来, 其分布时代从安妮期早期至卡尼期早期 (Orchard *et al.*, 2007; Chen *et al.*, 2016)。 *Gl. malayensis* (Nogami, 1968) 与 *Gl. tethydis* 的主要区别在于前者齿台更宽, 主齿位于末端, 基坑膨大且位置接近末端。 *Gl. malayensis* 分布严格受沉积相控制, 多报道于特提斯和泛大洋较深水的环境中 (Mietto *et al.*, 2007; Muttoni *et al.*, 2014; Zhang *et al.*, 2019)。该种最早出现于拉丁期晚期, 并延续至卡尼期早期 (Chen *et al.*, 2016)。在中国, *Gl. malayensis* 仅在贵州关刀剖面 (覃斌贤等, 2023)、踊跃剖面 (Zhang *et al.*, 2017) 和云南罗平以则剖面 (Zhang & Sun, 2023) 的拉丁期或卡尼期地层中有报道。本研究在边阳组下部泥晶灰岩 (KBC-7) 采获两枚齿台特征与 *Gl. malayensis* 极为相似的 *Gladigondolella* 分子 (图3-6, 7), 但因齿台后部缺失, 无法确认, 因此暂定为 *Gl. cf. malayensis*。

Budurovignathus 是拉丁期至卡尼期早期比较稀有但具有非常重要地层研究价值的牙形石动物群, 主要分布于西特提斯地区 (Hirsch, 1972; Kovács & Kozur, 1980; Balini *et al.*, 2000; Plasencia *et al.*, 2004; Gaetani *et al.*, 2015; Maron *et al.*, 2019; Karádi *et al.*, 2022; Kolar-Jurkovšek *et al.*, 2023), 在北美 (Mosher, 1968; Orchard & Balini, 2007)、东南亚 (Ishida & Hirsch, 2011)、中东 (Hirsch & Gerry, 1974; Bandel & Waksmundzki, 1985) 和日本 (Nakada *et al.*, 2014; Zhang *et al.*, 2019; Tomimatsu *et al.*, 2021) 等地也有报道。在中国, *Budurovignathus* 动物群报道于贵州 (王红梅等, 2005; Lehmann *et al.*, 2015; Sun *et al.*, 2016; 江海水等, 2018; 覃斌贤等, 2023)、四川 (Jiang *et al.*, 2019)、云南保山地区 (董致中和王伟, 2006; 王伟等, 2019; Qin *et al.*, 2026) 和西藏 (田传荣, 1983; 武桂春等, 2007; Li *et al.*, 2025) 等地。 *Budurovignathus mungoensis* 是 *Budurovignathus* 属的特征分子, 最初由 Diebel (1956) 报道于拉丁阶上部地层。随后, 在全球不同沉积环境的拉丁期至卡尼期早期地层中均有该分子的报道 (如: Mosher, 1968; 王红梅等, 2005; Zhang *et al.*, 2019; Li *et al.*, 2025)。 *Bu. mungoensis* 的主要特征是具有长的自由齿片, “S形”齿台轮廓, 齿台边缘发育瘤齿, 反口面基坑明显前移至齿台中部。该种的首现可作为划分拉丁阶 Fasnian-Longobardian 亚阶界线的潜在标志 (覃斌贤等, 2023)。在加拿大不列颠哥伦比亚省和美国内华达 (Orchard & Balini, 2007), *Bu. mungoensis* 常与 *Paragondolella inclinata* 和 *Quadralella aff. acuminatus* 共生。在缺乏卡尼期

典型牙形石分子的情况下, 该牙形石组合可作为拉丁期晚期的重要指示标志。在中国, *Bu. mungoensis* 仅报道于贵州关刀剖面 (王红梅等, 2005; Lehmann *et al.*, 2015; 覃斌贤等, 2023)、云南保山地区 (王伟等, 2019; Qin *et al.*, 2026) 和西藏措勤地区 (Li *et al.*, 2025), 可与 *Q. polygnathiformis* 和 *Q. intermedius* 共生, 指示拉丁期晚期至卡尼期早期。

本次研究在呢罗段上部瘤状灰岩 (KBC-5) 和生物屑灰岩 (KBC-6) 中分别采获 *Paragondolella excelsa*, *Pg. inclinata*, *Pg. cf. willistonensis* 和 *Quadralella aff. polygnathiformis*。尽管后两者常见于卡尼期早期, 但这两个标本与模式种存在明显区别, 不适合用来限定地层时代。 *Pg. excelsa* 的分布时代为安妮期 Illyrian 早期-拉丁期 Fasnian 晚期, *Pg. inclinata* 的时代为拉丁期 Longobardian 早期-卡尼期 Julian 晚期。根据所采获的牙形石组合特征, 认为呢罗段上部时代为拉丁期晚期。前人在呢罗段下部地层报道安妮阶常见菊石 *Balatonites* (贵州省地质矿产局, 2017), 因此, 本研究认为呢罗段的沉积时限为中三叠世安妮期-拉丁期晚期。

3 结 论

在贵州紫云四大寨乡卡标村剖面开展牙形石研究, 其牙形石丰度和多样性均较低, 但在呢罗段及边阳组中识别出了 *Budurovignathus*, *Gladigondolella*, *Paragondolella* 和 *Quadralella* 属。根据所采获的牙形石属种组合及分布特征, 结合前人报道的菊石, 认为呢罗段沉积时限为中三叠世安妮期-拉丁期晚期。这一研究成果可为进一步研究扬子台地西南缘中三叠世地层时代划分和区域对比以及南盘江盆地演化提供有意义的资料。

4 系统古生物学

牙形动物纲 *Conodonta* Pander, 1856

锯片石目 *Prioniodinida* Sweet, 1988

舟石科 *Gondolellidae* Lindström, 1970

杜洛夫石属 *Budurovignathus* Kozur, 1988

蒙戈布杜洛夫石 *Budurovignathus mungoensis* (Diebel, 1956)

(图3-9)

1958 *Polygnathus mungoensis*; Huckriede, Taf. 14, Figs. 23, 24.

1968 *Polygnathus cf. mungoensis*; Hayashi, Pl. 3, Fig. 4.

1972 *Tardogondolella mungoensis catalana*; Hirsch, Pl. 1, Figs. 7-10.

- 1980 *Metapolygnathus mungoensis*; Kovács & Kozur, Taf. 7, Fig. 3.
 2000 *Budurovignathus mungoensis*; Balini *et al.*, Pl. 2, Fig. 1.
 2005 *Budurovignathus mungoensis*; 王红梅等, 图版I, 图2-4。
 2007 *Budurovignathus* sp.; 武桂春等, 图版II, 图21。
 2019 *Budurovignathus mungoensis*; Zhang *et al.*, Fig. 7.26.
 2023 *Budurovignathus mungoensis*; 覃斌贤等, 图2.12, 2.13, 3.1, 5.1。
 2025 *Budurovignathus mungoensis*; Li *et al.*, Figs. 6.4, 6.5.
 2026 *Budurovignathus mungoensis*; Qin *et al.*, Pl. 1, Figs. 1-5.

特征 口视: 齿体中等长度, 自由齿片发育, 占齿体长度约1/4。齿台明显不对称, 在后部约1/5处向内侧弯曲并迅速收缩变尖, 固定齿脊亦向内侧偏斜并延伸至齿台末端, 齿台中部两侧边缘发育2-3个明显、分离的瘤齿。侧视: 前部自由齿片高, 向后降低, 齿脊上细齿分离。反口面: 基坑小, 位于齿台1/2-1/3处, 往后龙脊变窄, 从基坑处延伸至齿台末端并向内偏斜。

比较 该种具有多变的后部齿台和龙脊(Bandel & Waksmundzki, 1985)。本次采获的标本与关刀剖面(王红梅等, 2005; 覃斌贤等, 2023)的标本均表现为后部齿台逐渐向一侧收缩变尖, 在西特提斯和泛大洋地区的标本, 部分标本后部齿台迅速收缩并向一侧倾斜。*Budurovignathus mungoensis*与*Budurovignathus diebeli* (Kozur & Mostler, 1971)的区别是后者齿台末端近正方形, 龙脊在后部分岔。

剑舟石属 *Gladigondolella* Müller, 1962

特提斯剑舟石 *Gladigondolella tethydis* (Huckriede, 1958)

(图3-10)

- 1958 *Polygnathus tethydis* n. sp. Huckriede; Taf. figs. 39, 40; Taf. 12, figs. 1, 38; Taf. 13, figs. 2-5.
 1968 *Gladigondolella tethydis*; Hayashi, Pl. 3, Fig. 8.
 1968 *Gladigondolella tethydis*; Mosher, Pl. 116, Figs. 1, 2, 5, 8.
 2005 *Gladigondolella tethydis*; 王红梅等, 图版II, 图2, 3。
 2015 *Gladigondolella tethydis*; Lehrmann *et al.*, Figs. 6.26, 6.27.
 2019 *Gladigondolella* cf. *tethydis*; Zhang *et al.*, Fig. 7.21.
 2023 *Gladigondolella tethydis*; 覃斌贤等, 图2.6。

特征 口视: 齿台中等宽度, 长, 最宽处位于中部或后部1/3处, 向前收缩, 后末端呈宽圆状, 在主齿处齿台稍向一侧弯曲, 近脊沟浅, 蜂窝状纹饰覆盖整个齿台。侧视: 齿脊较低, 由10个低、分离的瘤齿组成, 主齿位于齿台后部约1/3处, 主齿后有2个细齿。反口视: 基坑稍膨大, 位于齿台后部约1/3处。龙脊窄, 齿槽窄至中等宽度, 由基坑延伸至前末端。

比较 *Gladigondolella tethydis*与*Gladigondol-*

*ella malayensis*相比, 后者齿台较宽, 主齿位于末端, 基坑膨大, 位于近末端; 前者的基坑相对较小且前移至齿台中部或后部1/3处, 主齿位于后部约1/3处, 主齿后有1-2个细齿。

马来亚剑舟石相似种 *Gladigondolella* cf. *malayensis* Nogami, 1968

(图3-6, 7)

- 1968 *Gladigondolella malayensis* sp. nov. Nogami; Taf. 9, Figs. 11-18; Taf. 11, Fig. 7.
 2000 *Gladigondolella malayensis malayensis*; Balini *et al.*, Pl. 2, Fig. 2.
 2017 *Gladigondolella malayensis*; Zhang *et al.*, Fig. 5.12, 6.4, 8.7.
 2019 *Gladigondolella malayensis*; Zhang *et al.*, Fig. 7.22.
 2023 *Gladigondolella malayensis*; 覃斌贤等, 图2.5。

特征 口视: 齿体较宽, 椭圆状, 最宽处位于中部, 向前逐渐收缩至前末端变尖, 近脊沟浅, 蜂窝状纹饰几乎覆盖整个齿台。侧视: 齿台边缘厚, 齿脊低, 由6-8个分离的瘤齿组成。反口视: 基坑膨大呈眼球状, 位于近末端, 龙脊窄且高, 齿槽窄至中等宽度, 从基坑处延伸至前末端。

比较 本次所获得的标本齿台轮廓与*Gladigondolella malayensis*极为相似, 但因缺失后部齿台, 暂定为*Gl. cf. malayensis*。

似舟石属 *Paragondolella* Mosher, 1968

斜脊似舟石 *Paragondolella inclinata* (Kovács, 1983)

(图3-4)

- 1983 *Gondolella foliata inclinata* n. subsp. Kovács; Pl. 1, Figs. 1-4; Pl. 3, Figs. 2-4.
 2000 *Paragondolella inclinata*; Balini *et al.*, Pl. 3, Fig. 2.
 2005 *Paragondolella foliata inclinata*; 孙作玉等, 图版I, 图1-6, 10。
 2005 *Neogondolella inclinata*; 王红梅等, 图版II, 图8, 13, 19, 21。
 2007 *Paragondolella inclinata*; Orchard & Balini, Figs. 6.7-6.11, 6.24, 6.25.
 2013 *Paragondolella inclinata*; 覃斌贤等, 图4.1, 4.2。
 2017 *Paragondolella inclinata*; Zhang *et al.*, Fig. 6.13, 7.2, 8.1.
 2018 *Paragondolella inclinata*; Zhang *et al.*, Figs. 4AQ-4AS, 6G-6L, 6AH-6AJ, 7M-7O, 7V-7X, 8Y-8AA.
 2023 *Paragondolella inclinata*; Zhang *et al.*, Fig. 7.18.

特征 口视: 齿台宽, 中等长度, 最宽处位于后部2/3, 向前逐渐收缩。齿台几乎覆盖整个齿体, 仅前部1-2个细齿为自由齿片。齿台末端宽圆形, 齿脊延伸至后部, 可见窄的齿台后边缘。除了近脊沟外, 蜂窝状纹饰覆盖整个齿台。侧视: 齿体微拱曲, 齿脊由高度融合的细齿组成, 前部很高, 向后逐渐降

低直至主齿处。齿台边缘微上翻,前部的膝折或台阶构造不明显。反口视:基坑位于后部,龙脊中等宽度,后部呈卵圆形环绕基坑,齿槽窄,从基坑处延伸至齿台前末端。

比较 *Paragondolella inclinata*与*Quadralella polygnathiformis* (Budurov & Stefanov, 1965)的区别是,后者的齿台前边缘上翻,形成膝折或台阶构造。该种与*Paragondolella foliata* (Budurov, 1975)极为相似,但后者齿台底缘平直,齿脊上的细齿近乎垂直于齿台,前者齿台明显拱曲或弓形。

威利斯顿似舟石相似种 *Paragondolella cf. willistonensis* Orchard, 2007

(图3-3)

2007 *Paragondolella willistonensis* sp. nov.; Orchard, Figs. 3.16–3.18.

2007 *Paragondolella willistonensis*; Orchard & Balini, Figs. 6.29–6.31.

特征 口视:齿体小,齿台呈双凸,最宽处位于后部约1/4处,向前后逐渐收缩,至齿台后末端急剧收缩,使齿台末端呈狭窄球状。侧视:齿台平直略弯曲,齿脊由高度融合的细齿组成,近乎等高,后部稍降低。反口视:基坑位于齿台末端,被环台面包围,龙脊窄,延伸至齿台前末端。

比较 本次所采获的标本为幼年分子,但齿台特征与*Pg. willistonensis*较为相似。

高似舟石 *Paragondolella excelsa* Mosher, 1968

(图3-1, 5)

1968 *Paragondolella excelsa* n. sp.; Mosher, Pl. 118, Figs. 1–8.

1975 *Gondolella excelsa*; Zawidzka, Pl. 37, Figs. 22, 25.

1989 *Neogondolella excelsa*; Kovács & Kozur, Taf. 3, Fig. 7.

2005 *Paragondolella excelsa*; 王红梅等,图版II,图15, 17.

2015 *Paragondolella ex gr. excelsa*; Lehrmann et al., Fig. 6.11.

2023 *Paragondolella excelsa*; 覃斌贤等,图2.7, 2.8.

特征 口视:齿体中等大小,最宽处位于后部约1/3–1/4处,向前逐渐变窄,齿台后部窄圆形。齿台几乎延伸整个齿体长度,主齿近末端,发育窄的齿台后边缘。侧视:齿台中等厚度,略微弯曲,边缘略微向上翻卷。齿脊由很高的细齿组成,中等融合,中部最高,向前后逐渐降低。反口视:龙脊中等宽度,末端呈喇叭状,基坑中等大小,位于后部。

比较 该种与*Pg. inclinata*很相似,但前者齿脊中部最高,向前后降低;后者齿脊最高位于前部,向后逐渐降低。

四棱石属 *Quadralella* Orchard, 2013

多颚形四棱石近亲种 *Quadralella aff. polygnathiformis* (Budurov et Stefanov, 1965)

(图3-2, 8)

特征 口视:齿台宽且长,齿台边缘近平行,最宽处位于末端,齿台几乎覆盖整个齿体,无自由齿片。主齿中等大小,位于近末端,在一侧或两侧发育两个细齿,齿脊延伸至主齿处,在主齿后部发育窄的后边缘。侧视:齿体略弯曲,齿脊由高度融合的细齿组成,前部高,向后降低至主齿处。齿台后部边缘上翻,个别标本后齿台边缘几乎与齿脊等高。反口视:基坑位于末端,龙脊中等宽度,末端方圆形,齿槽窄,向前延伸至前末端。

比较 Orchard和Balini (2007)及江海水等(2018)对*Q. polygnathiformis*特征进行修订,认为该种具有以下六个特征:(1)齿台后部为圆形或方圆形;(2)齿台延伸达整个齿体的长度,口视逐渐向前变窄,无向内的明显变弯;(3)侧视齿台前部一侧或两侧具明显的膝状弯曲;(4)齿脊中等高度并融合,但侧视时可能被翻卷的齿台边缘所阻挡;(5)前齿片有分化并部分融合,突出于向下弯曲的前齿台之上;(6)主齿大、显著,位于齿台近末端,明显区别于齿脊上融合的瘤齿,靠近后部被一窄的齿台边缘所包围。他们一致认为“侧视齿台前部一侧或两侧具明显的膝状弯曲”是*Q. polygnathiformis*最主要的鉴定特征。本研究的标本特征与*Q. polygnathiformis*极为相似,但齿台前部没有明显的膝状弯曲,可能是*Pg. inclinata*向*Q. polygnathiformis*演化的中间类型,或是*Q. polygnathiformis*种群的早期类型。

致谢 感谢两位匿名审稿人及编辑对本文提出的宝贵修改建议。牙形石扫描电镜拍照在中国地质大学(武汉)地质微生物与环境国家重点实验室完成。

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CONODONTS OF THE NILUO MEMBER FROM ZIYUN AREA, GUIZHOU PROVINCE, AND THEIR AGE SIGNIFICANCE*

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Abstract A marine sequence of claystone interbedded with carbonate (Niluo Member) is developed in the upper part of Xuman (Xinyuan) Formation of the Middle Triassic in the southern Guizhou Province. In this study, conodonts from the Niluo Member and the Bianyang Formation were collected and identified. The conodont assemblage consists of *Budurovignathus mungoensis*, *Paragondolella excelsa*, *Paragondolella inclinata*, *Gladigondolella* cf. *malayensis*, *Gladigondolella tethydis*, *Paragondolella* cf. *willistonensis* and *Quadralella* aff. *polygnathiformis*. Among with, *Budurovignathus mungoensis* was first discovered in this area except for the Guandao section. Based on the diagnostic conodonts assemblage and integrated with previously reported ammonites, the Niluo Member was deposited during the Anisian–late Ladinian interval of the Middle Triassic. This study provides valuable data for stratigraphic subdivision, inter-regional correlation, and further understanding of Middle Triassic basin evolution in the Nanpanjiang Basin.

Key words conodont, Niluo Member, Triassic, Ziyun of Guizhou Province

* This work was supported by the Natural Science Foundation of Guangxi (2026GXNSFAA00641070), the Fundamental Research Funds for Central Public Welfare Research Institutes, Institute of Karst Geology, CAGS (YRQN2025003) and the Geological Survey Projects of the China Geological Survey (DD202501029).

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