贵州安龙坡脚剖面中三叠世安尼期牙形石的发现及其意义

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内容提要: 贵州安龙坡脚剖面新苑组位于扬子地台和右江盆地交汇处,为中三叠世台缘斜坡相沉积,在该组中上部发现了牙形石动物群,除少量分枝分子外,都归属于 *Neogondolella* 属,建立了4个牙形石带,自下而上分别为: *Neogondolella bulgarica*、*Neogondolella bifurcata*、*Negondolella constricta*、*Neogondolella constricta cornuta*(未见顶界)带。时代为中三叠世安尼中晚期,其特殊的古地理位置,对系统研究与对比罗平生物群、盘县动物群的古生态环境,以及区域地层对比、地层格架建立,探讨该时期盆地演化提供了基础资料。

关键词:新苑组;安尼期;牙形石;罗平生物群;贵州安龙

罗平生物群(张启跃等, 2008)是三叠纪生物全面复苏与辐射的标志性生物群,它是以食物链顶端的海洋爬行动物为主而重建的正常海洋生态系统(Solé et al., 2002; Hu Shixue et al., 2011),它产于关岭组二段中部的灰黑色中薄层泥晶灰岩中,时代为中三叠世安尼期的 Pelsonian 亚期(Kozur, 2003)。其北侧的盘县动物群也在该层位发现富集成层的海生爬行动物、鱼类及多门类无脊椎动物化石(Wang Liting et al., 2001; Sun Zuoyu et al., 2006)。最近通过1:5万区域地质调查,我们在云南泸西(Huang Jinyuan et al., 2013)、丘北、富源、贵州兴义(谢韬等, 2016)等地发现同时期的化石点(图1),极大的拓展了该时期生物群的分布。上述古生物化石多为原地埋藏保存(张启跃等, 2008),这需要当时的环境、气候有利于生物的繁衍,该时期安龙雷公滩—坡段一线碳酸盐岩台地边缘的生物建隆的障壁作用使西侧台地处于半封闭—封闭的局限浅海环境(图2),这种特殊的古地理环境为生物提供了良好的生存环境。本文在安龙雷公滩—坡段一线以东安龙坡脚斜坡相新苑组中发现同上述生物群层位同时代的牙形石生物地层,对其岩石组合沉积环境研究,为进一步了解当时的古地理环境提供资料。

1 剖面描述

贵州安龙坡脚新苑组剖面位于扬子地台与右江盆地交汇处,其北侧为扬子地块碳酸盐台地,南侧为南盘江碎屑岩盆地。该剖面出露新苑组上部地层,以斜坡相浊流沉积为主,属扬子地台与右江盆地过渡型沉积,剖面位于贵州安龙县坡脚乡(图1),剖面起点地理坐标为24°58′36.8″N,105°26′52.7″E,终点地理坐标为24°58′24.8″N,105°26′46.8″E。

边阳组(未见顶)

22层:灰绿色薄层状泥岩夹土黄色中—薄层状细砂岩。

——整合——

新苑组

21层:土黄色、灰绿色薄层状泥岩夹灰质条带、灰岩透镜体。含牙形石: *Neogondolella constricta*, *Paragondolella excelsa*, *Prioniodella decrescens*, *Prioniodella* sp., *Lonchodina mülleri*, *Neogondolella constricta cornuta* 8.41 m

20层:厚块状灰色砂屑灰岩、砾屑灰岩,单层厚度大于2 m 10.31 m

19层:土黄色薄层状泥岩夹泥灰岩。泥灰岩层面不平整,呈疙瘩状 4.30 m

18层:灰色中厚层状含砾屑灰岩夹土黄色薄层状泥岩。含牙形石: *Neogondolella* cf. *constricta*, *Cypridodella venusta*, *Neogondolella* sp., *Cypridodella spengleri* 4.32 m

17层:灰色厚块状砾屑灰岩,单层厚度大于2 m 4.91 m

注: 本文为中国地质调查局项目《贵州1∶5万兴义县、郑屯、安龙县幅区域地质矿产调查》(编号:12120114068101)、《南盘江成矿区贞丰和富宁地区地质矿产调查》(编号:DD20160020)和国家自然科学基金项目《应用同步加速器X射线层析显微技术重建云南罗平中三叠世牙形石多分子器官》(批准号:41502013)的成果。
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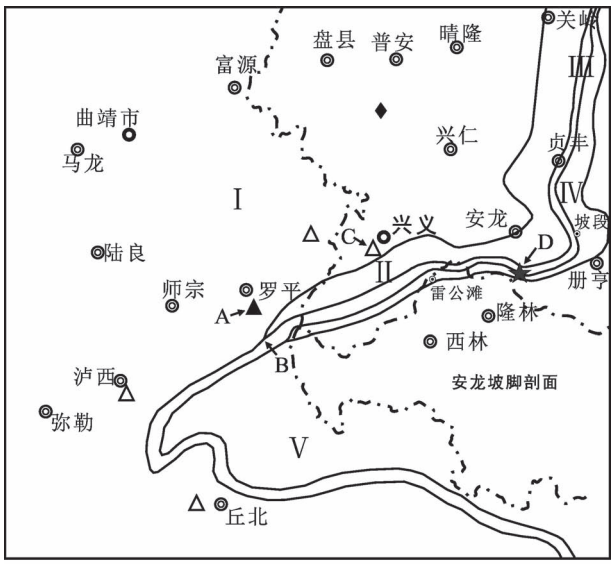

省界(Provincial boundary)　★安龙坡脚剖面(Pojiao section)
▲ 罗平生物群(Luoping biota)　♦盘县动物群(Panxian fauna)
△ 其他安尼期化石点(Other fossil occurrence(Anisian))

图 1 贵州安龙及邻区中三叠世安尼期岩相古地理图(据王志浩和钟端,1994;梅冥相等,2003;崔克信等,2004 修改)

Fig. 1 The lithofacies Paleogeographic map showing the Anisian age of Middle Triassic in Anlong area and its adjacent areas (modified from Wang Zhihao and Zhong Duan, 1994;Mei Mingxiang et al., ,2003;Cui Kexin et al., 2004)

Ⅰ—半局限台地相; Ⅱ—局限台地相; Ⅲ—台地边缘礁滩相; Ⅳ—台缘斜坡相; Ⅴ—深水盆地相

Ⅰ—Semi-restricted platform facies; Ⅱ—Restricted platform facies; Ⅲ— Reef—shoal facies on edge of platform; Ⅳ— Slope facies on edge of platform; Ⅴ—Deep-water basin facies

16 层:灰色薄层状微晶灰岩夹灰色中层状砂屑灰岩。含牙形石:*Neogondolella hanbulogi*, *Lonchodina multihamato*, *Neogondolella* cf. *bifurcata*　3.06 m

15 层:厚块状砾屑灰岩,单层厚度大于 2m　3.81 m

14 层:灰色中层状砂屑灰岩,夹薄层状砂屑灰岩。含牙形石: *Neogondolella bifurcata*, *Prioniodella ctenoides*, *Gladigondolella tethydis*, *Neogondolella bulgarica*　4.11 m

13 层:灰色厚块状含砾屑灰岩,单层厚度约为 2 m　6.34 m

12 层:灰色薄层状砂屑灰岩夹泥岩。含牙形石: *Gladigondolella tethydis*, *Prioniodina excavate*, *Ozarkodina tortilis*, *Prioniodina* sp.　11.99 m

11 层:中层深色含燧石结核灰岩、青灰色极薄—薄层状泥岩。灰岩见大量生物碎屑,以海百合茎为主,泥岩具有水平纹层。含牙形石: *Neogondolella bifurcata*, *Neogondolella bulgarica*, *Neogondolella* sp., *Gladigondolella tethydis*, *Cypridodella spengleri*, *Neogondolella* cf. *cornuta*, *Neohindeodella* sp.和微体鱼类、海绵骨针等　12.13 m

10 层:薄层—极薄层灰黄色泥岩夹深灰色中—薄层状生物碎屑灰岩。含牙形石: *Gladigondolella tethydis*, *Cypridodella spengleri*, *Cratognathodus posterognathus*, *Cratognathodus Kochi*, *Prioniodina petraeviridis* 等和微体鱼类　1.01 m

9 层:土黄色、青灰色薄层状泥岩　9.02 m

8 层:灰色角砾状灰岩。含牙形石: *Gladigondolella tethydis*, *Lonchodina müleri*, *Neogondolella hanbulogi*, *Prioniodina* sp., *Neohindeodella* sp.等及微体鱼类　4.04 m

7 层:青灰色薄层状泥岩,具有水平层理　23.57 m

6 层:青灰色薄层泥岩夹灰绿色中—薄层状细砂岩,砂岩中见大量植物碎屑　21.27 m

5 层:土黄色中厚层状细砂岩夹青灰色泥岩,泥岩发育水平层理,砂岩中见大量植物碎屑　20.39 m

4 层:灰色厚块状砂屑灰岩,单层厚度约为 2 m,见海百合碎屑。含牙形石 *Lonchodina* sp.和微体鱼类　3.62 m

3 层:灰—深灰色中—薄层状生物碎屑灰岩、土黄色中—薄层状泥岩。含牙形石: *Gladigondolella tethydis*, *Neogondolella bulgarica*, *Neogondolella hanbulogi*, *Neogondolella* sp., *Neohindeodella petraeviridis*, *Lonchodina spengleri*, *Ozarkodina tortilis*, *Gladigondolella matayensis budurovi*, *Hibbardella* sp., *Lonchodina cf*

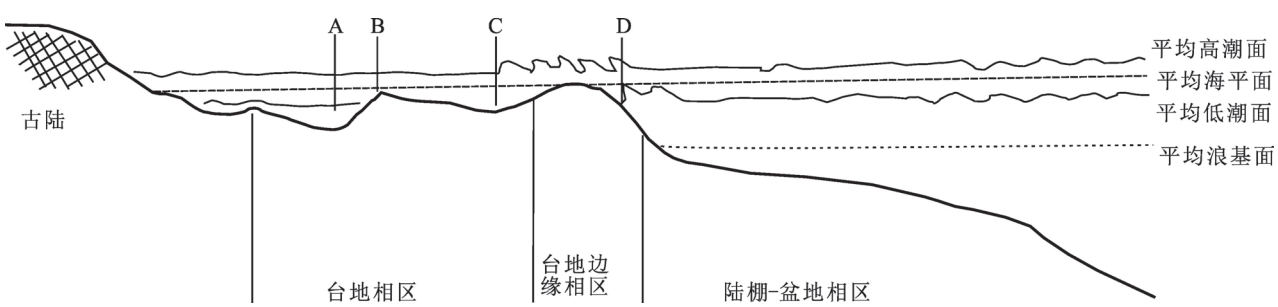

图 2 贵州安龙及邻区中三叠世安尼期沉积模式图

Fig. 2 The Sedimentary pattern showing the Anisian age of Middle Triassic in Anlong area and its adjacent areas

A—罗平大洼子;B—罗平石山脚;C—兴义雷打田;D—安龙坡脚剖面

A—Dawazi Village, Luoping County;B—Shishanjiao Village, Luoping County;C—Leidatian Village, Xingyi City;D—Pojiao Section, Anlong County

mülleri, *Prioniodina* cf. *magnidentata* 等和微体鱼类 10.60 m

2 层:中—薄层状灰绿色细砂岩、灰绿色粉砂质泥岩组成,向上泥质成分增多,砂岩中见大量植物碎屑 21.97 m

1 层:灰色—深灰色中—薄层状生物碎屑灰岩夹灰黑色、褐黄色薄层状泥岩,灰岩中见大量生物碎屑,以海百合茎为主。含牙形石:*Gladigondolella tethydis*, *Prioniodella* cf. *decrescens*, *Cypridodella conflexa*, *Parachirognathus* sp., *Neogondolella* sp.等及微体鱼类 1.22 m

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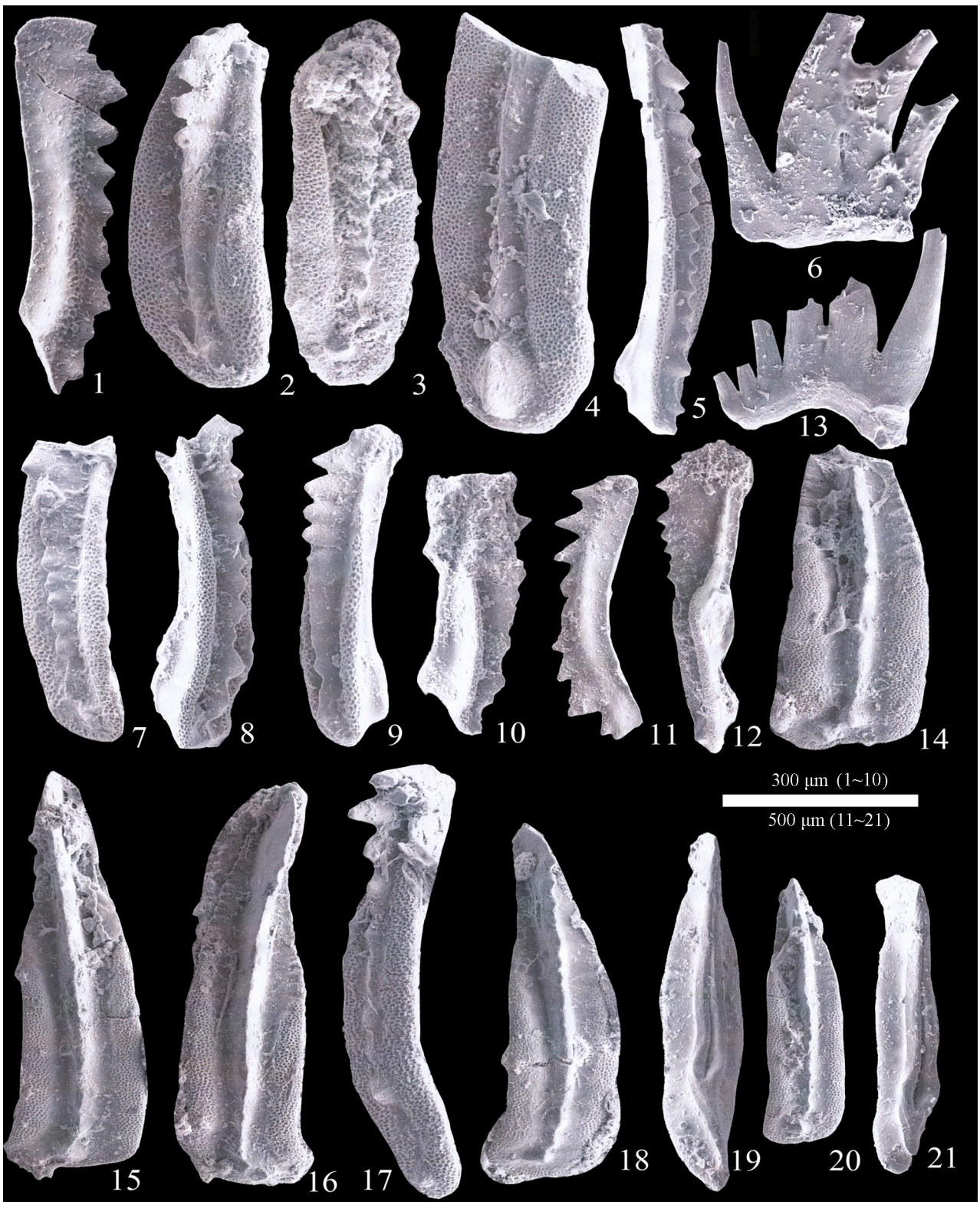

图 3 贵州安龙坡脚剖面新苑组牙形石化石

Fig.3 Illustrations of conodonts from the Xinyuan Formation, Pojiao section

1—*Neogondolella* sp., 11 层;2、3、7—*Neogondolella constricta*, 21 层;4、8、9—*Neogondolella hanbulogi*, 3 层;5、10、14、20—*Neogondolella bulgarica*, 分别采自 3 层、3 层、11 层、14 层;6—*Parachirognathus* sp.,1 层;11—*Neogondolella* cf.*constricta*, 18 层;12—*Neogondolella constricta cornuta*, 21 层; 13—*Prioniodella* cf. *decrescens*, 1 层; 15、16、18—*Neogondolella bifurcata*, 分别采自 11 层、11 层、14 层; 17、19、21—*Gladigondolella tethydis*, 3 层;1~10 比例尺 300 μm; 11~21 比例尺 500 μm

1—*Neogondolella* sp., bed 11; 2,3,7—*Neogondolella constricta*, bed 21; 4,8,9—*Neogondolella hanbulogi*, bed 3; 5,10,14,20—*Neogondolella bulgarica*, bed 3, bed 3, bed 11, bed 14; 6—*Parachirognathus* sp., bed 1; 11—*Neogondolella* cf.*constricta*, bed 18; 12—*Neogondolella constricta cornuta*, bed 21; 13—*Prioniodella* cf. *decrescens*, bed 1; 15, 16, 18—*Neogondolella bifurcata*, bed 11, bed 11, bed 14; 17, 19, 21—*Gladigondolella tethydis*, bed 3;1~10 Scale bar=300 μm; 11~21 Scale bar=500 μm

2　牙形石生物地层

贵州安龙坡脚新苑组剖面,牙形石化石分带性较强,具有重要的时代对比意义,可识别出 4 个与国内外进行对比的牙形石带,自下而上分别为:*Neogondolella bulgarica*、*Neogondolella bifurcata*、*Negondolella constricta* 和 *Neogondolella constricta cornuta* 带。

Neogondolella bulgarica 带,下界以带分子(图 3 中 5、10)的出现为特征;上界以出现 *Neogondolella bifurcata* 为标志,此带除带分子外,其它组成分子颇多,重要的有 *Neohindeodella petraeviridis*, *Lonchodina spengleri*, *L.müleri*, *Ozarkodina tortilis*, *Neogondolella hanbulogi*(图 3 中 4、8、9), *Cratognathodus kochi*, *C. posterognathus*, *Prioniodina petraeviridis*。*Gladigondolella tethydis*(图 3 中 17、19、21)贯穿整个本带,另外还伴生许多微体鱼类的鱼牙和鱼鳞化石,重要的有:*Mucrovenator minimus*, *Complanicorona* aff. *C.rugosimargines*。*Neogondolella bulgarica* 最早报道于保加利亚 Golo Bardo Mountain 地区(Budurov and Stefanov,1975),常见于特提斯生物区和太平洋生物区安尼期 Bithynian 亚期至 Pelsonian 亚期地层(Pisa et al., 1980; Budurov and Trifonova, 1995)。在中国,*Neogondolella bulgarica* 发现于贵州关岭一带的杨柳井组下部(陈立德和王成源, 2009)和贵州省盘县羊圈-楚皮凹剖面关岭组上段(孙作玉等, 2014)。

Neogondolella bifurcata 带,底界以带分子(图 3 中 15、16、18)的首出现为标志,顶界以 *Neogondolella constricta* 的首现为标志;*Neogondolella bulgarica*(图 3 中 14、20),*Gladigondolella tethydis* 继续延续本带,其它重要的组成分子有:*Neogondolella hanbulogi*, *Prioniodina excavate*, *Prioniodella ctenoides*, *Lonchodina multihamato*, *Neogondolella* sp.(图 3 中 1), *Ozarkodina tortilis* 以及 *Neogondolella* cf.*cornuta*。*Neogondolella bifurcata* 最早发现于保加利亚的 Golo Bardo Mountain 地区,以其为带分子建立的化石带被认为是中三叠统安尼阶 Illyrian 亚阶最下部的一个牙形石带(Budurov and Stefanov, 1972; Kozur, 1980)。在中国,*Neogondolella bifurcata* 见于贵州平坝板纳组(王志浩和钟端, 1994)、贵州青岩剖面垄头组下部(武桂春等, 2008)和贵州省盘县羊圈-楚皮凹剖面关岭组上段(孙作玉等, 2014)。

Negondolella constricta 带,此带的底界以带分子(图 3 中 2、3、7、11)的首现为特征;顶界以 *N. constricta cornuta* 的出现为标志。伴生的分子有:*Cypridodella venusta*, *C. spengleri* 等。*Neogondolella constricta* 最早由 Mosher 和 Clark(1965)发现于北美内华达的 Prida 组,由其建立的化石带代表安尼期 Illyrian 亚期(Kozur, 2003; Sweet et al., 1970)。在中国,*Neogondolella constricta* 见于西藏聂拉木县土隆群中组(王成源和王志浩,1976)、贵州紫云石头寨剖面新苑组(丁梅华和黄清华,1990)、贵州平坝肖家乡剖面青岩组(秦典夕等, 1993)、云南开远和贵州平坝地区的法郎组和兰木组(王志浩和钟端, 1994)、贵州罗甸檬江剖面许满组(王红梅, 1996)、贵州罗甸关刀(2)剖面关刀岩楔(王红梅等, 2005)、贵州青岩剖面垄头组下部(武桂春等, 2008)、贵州省盘县羊圈-楚皮凹剖面关岭组上段(孙作玉等, 2014)和贵州册亨坡段组(薄婧方等, 2017)。

Neogondolella constricta cornuta 带,此带的底界以带分子(图 3 中 12)的首现为特征,未见顶。伴生分子有:*Paragondolella excelsa*, *Prioniodella decrescens*, *Lonchodina mülleri* 等。*Neogondolella constricta cornuta* 最早由 Kovács 等(1990)基于

表 1 贵州安龙地区及邻区中三叠世安尼期沉积相带特征对比表(据贵州省地质调查院, 2017 修改)

Table 1 Correlation of sedimentary facies in Anisian age of Middle Triassic in Anlong area and its adjacent areas (modified from Geological Survey of Guizhou Province, 2017)

相带名称	岩石地层单位	岩性特征
半局限台地相	关岭组	灰岩、白云岩、白云质泥岩、杂色泥岩(罗平生物群产出层位)
局限台地相	花溪组	藻白云岩、泥晶白云岩夹灰质白云岩
台地边缘生物礁、滩相	坡段组	浅灰色、灰白色厚块状砂屑生物屑灰岩
台缘斜坡相	新苑组	粉砂岩、泥岩夹灰岩、泥灰岩、砾屑灰岩夹钙屑浊积岩、滑塌角砾岩
盆缘斜坡—深水盆地相	许满组	泥岩及细砂岩、粉砂岩夹灰岩、泥灰岩、生物介壳灰岩

Nicora 等(1984)从 *Neogondolella constricta* 划分出的“cornuta”形态型建立。*Neogondolella constricta cornuta* 在地层中的首现,大致对应安尼阶 Illyrian 亚阶底界(Meco, 1999)。在中国, *Neogondolella constricta cornuta* 见于贵州罗甸关刀(2)剖面关刀岩楔(王红梅等, 2005)、贵州省盘县羊圈-楚皮凹剖面关岭组上段(孙作玉等, 2014)。

3 岩性组合特征

根据岩性、岩相等组合特征,该剖面在垂向上可以划分为 3 个岩性段:一段(1~4 层)和三段(8~21 层)岩性主要为夹薄至厚层块状生物碎屑岩、砂屑灰岩、砾屑灰岩和中—薄层粉砂岩、细砂岩的黄灰色泥岩,根据沉积特征、剖面序列等宏观特征观察,泥岩系原地慢速悬浮堆积即背景冲积物,生物碎屑灰岩均为异地搬运沉积,物源来自于北侧的上扬子台地,依据规模和层内结构可以分为碎屑流、浊流和规模较大的块体流异地堆积(即楔状体)(图 4a—d);二段(5~7 层)岩性为细砂岩、粉砂岩和泥岩组成的浊流沉积,细砂岩、粉砂岩中可见植物碎片和炭屑,为来自不同方向的陆源碎屑岩(图 4e、f)。综合分析总体为一套台缘斜坡相沉积。

4 讨论

罗平生物群、盘县动物群位于牙形石带 *Nicoraella kockeli* 带,时代为中三叠世安尼期的 Pelsonian 亚期(Zhang Qiyue et al., 2009;Sun Zuoyu et al., 2006)。*Nicoraella kockeli* 最早报道于德国盆地 Muschelkalk 组(Tatge, 1956),它是德国盆地和特提斯生物区安尼期 Pelsonian 亚期的标志分子,通常与 Pelsonian 亚期菊石分子共生(Kozur, 2003; Pisa et al., 1980; Kozur,1980; Narkiewicz, 1999)。安龙坡脚剖面新苑组剖面该段地层时代为中三叠世安尼期 Bithynian 亚期至 Illyrian 亚期,未进入拉丁期,该段地层可以邻区进行对比。

从罗平大洼子到安龙坡脚,由西向东,沉积格局为半局限—局限台地—台地边缘滩—台缘斜坡—深水盆地(图 1),其相带特征如表 1 所示。半局限台地内关岭组沉积灰岩夹泥岩、白云岩的岩石组合,具有水平层理、生物扰动等沉积构造,化石丰富。局限台地内花溪组沉积以白云岩为主的一套组合,具有藻纹层、水平纹层,小型交错层理、鸟眼构造,大化石稀少,显示水体安静而咸化的特点。台地边缘生物滩坡段组主要沉积一套浅灰色、灰白色厚块状砂屑生物屑灰岩,生物屑主要为藻屑,而砂屑的磨圆度和分选性好,为亮晶方解石胶结,显示了海水浅而水动力强的环境特征。台缘斜坡新苑组为一套砂泥岩、灰岩夹砾屑灰岩的岩石组合,塌构造发育,化石丰富,主要以菊石、双壳和腕足为主。深水盆地许满组出露一套深水灰泥与陆源碎屑浊流沉积,陆源碎屑浊积岩由粉至细砂级石英砂岩、泥质粉砂岩、粉砂质泥岩、泥岩组成的复理石岩系,发育典型鲍马序列。

这种岩性、岩相的变化,直接导致中三叠世安尼期生物群落、海洋环境的改变。沿安龙雷公滩—坡段一线碳酸盐岩台地边缘的生物建隆的障壁作用使西侧台地处于半封闭—封闭的局限浅海环境,水动力较弱,水体较闭塞,但可能仍与其东的广海相通,这样的古环境有利于生物繁殖。在罗平生物群产出层位水平纹层发育(白建科等,2011),反应水体宁静;且地球化学特征显示气候比较温暖潮湿(孙媛媛等, 2009;周长勇等, 2014),生物大量繁殖。这种在台缘浅滩带之后,位于局限浅滩带内侧的古地理环境为古生物繁衍的较佳场所,如中三叠世拉丁期的兴义顶效贵州龙动物群(杨瑞东, 1997)、晚三叠世卡尼期的贵州关岭生物群(王尚彦, 2006)。

同时,在坡脚剖面 3 层、4 层、8 层、10 层、11 层发现大量的鱼牙和鱼鳞化石,其中 *Mucrovenator minimus* 在美国内华达州西北部的中三叠世安尼期

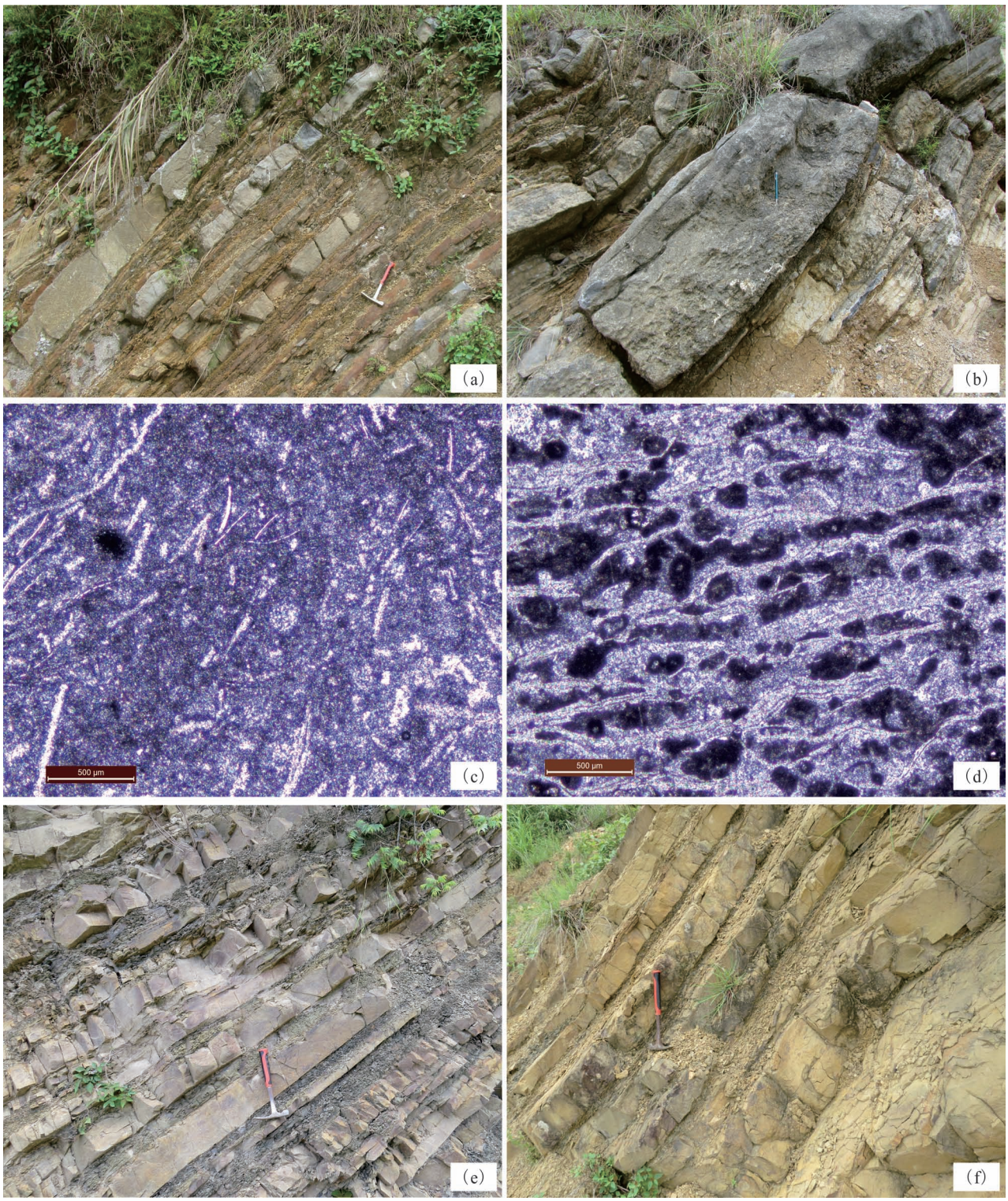

图 4 贵州安龙坡脚剖面新苑组岩性特征

Fig.4 The typical lithology from the Xinyuan Formation, Pojiao section

(a)—夹于泥岩之中的钙屑浊积岩和碎屑流砾屑灰岩;(b)—碎屑流成因的层状砾屑灰岩;(c)—生物碎屑灰岩,多为藻类和介屑;(d)—亮晶粒屑灰岩;(e)薄—厚层浊积砂岩,砂岩主要为岩屑砂岩;(f)—碎屑岩组成的浊流沉积

(a)—calciturbidites and calcirudites intercalated in the mudstone; (b)—layered calcirudites of debris flow origin; (c)—bioclastic limestones, biodebris is mainly consist of algae and shells; (d)—sparry grainstone; (e) thin—thick bedded turbidite sandstones, sandstone is mainly consist of lithic sandstone; (f)—turbidite deposits consisting of clastic rocks

地层中也有发现(*Cuny et al.*, 2001),其在坡脚剖面对应为牙形石 *Neogondolella bulgarica* 带,同罗平生物群时代相当(Budurov and Trifonova, 1995;Zhang Qiyue et al., 2009),由于罗平生物群以含大量鱼类化石为特征(张启跃等, 2008;Hu Shixue et al., 2011),推测这些鱼牙和鱼鳞来自西侧的台地内部。

5 结论

在贵州安龙坡脚剖面新苑组上部的层段中建立了 4 个与国内外进行对比的牙形石带,自下而上分别为: *Neogondolella bulgarica*、*Neogondolella bifurcata*、*Negondolella constricta* 和 *Neogondolella constricta cornuta*(未见顶界)带,时代为中三叠世安尼期 Bithynian 亚期至 Illyrian 亚期,未进入拉丁期。该剖面垂向上可以划分为 3 个岩性段,岩石组合为一套砂泥岩、灰岩夹砾屑灰岩,是台缘斜坡相沉积,可同台地相关岭组、花溪组,台地边缘生物礁、滩相坡段组以及深水盆地相许满组进行对比,对探讨该时期盆地演化具有重要意义。

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Discovery and significance of the conodonts (Anisian, Middle Triassic) from Pojiao section in Anlong area, Guizhou Province

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Objectives: The Pojiao section is located at the junction of Yangtze platform and Youjiang basin in Anlong county, Guizhou Province. Because of its special paleogeographic position, the research of the Pojiao section is useful for the comparison among Anlong area, Luoping Biota and Panxian Fauna in paleoecologcial environment and regional stratigraphy. It can help to build the stratigraphic framework.

Methods: The main methods of this investigation are surveying section and conodont biostratigraphy in detail. At the same time, we study regional correlation of the strata in the southwestern margin of the Yangtze platform.

Results: A group of conodonts were discovered in the Pojiao section, belonging to middle and upper part of the Xinyuan formation. Besides few ramiform elements, most elements are classified into the Genus *Neogondolella*. Four conodont zones have been established from bottom to top: *Neogondolella bulgarica* Zone, *Neogondolella bifurcata* Zone, *Negondolella constricta* Zone and *Neogondolella constricta cornuta* Zone (the top undefined).

According to lithologic character, we divided the section into third parts. It was composed of sandy mudstone, limestone and calcirudite.

Conclusions: The Xinyuan Formation in Pojia section is a platform-margin slope facies stratum of Middle Triassic. The appearance of conodonts indicate that the strata of this period was close to but not enter the Latinian period, belonging to the mid- and late-Anisian. This research has important significance for exploring basin evolution in this period.

Keywords: Xinyuan Formation; Anisian; conodont; Luoping Biota; Anlong, Guizhou Province

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