南盘江盆地及邻区早中三叠世层序地层格架及其古地理演化
——兼论从"滇黔桂盆地"到"南盘江盆地"的演变过程

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摘 要：二叠纪与三叠纪之交的大规模台地淹没事件使二叠纪时期的一些孤立台地被淹没而消亡，其后，研究区在三叠纪经历了从滇黔桂盆地到南盘江盆地的演化过程；在空间上，从连陆台地到浊积盆地以及发育在浊积盆地中的孤立碳酸盐台地，相分异特别明显，特别是南宁和靖西一带孤立台地上早三叠世的鲕粒滩以及连陆台地边缘的礁滩相灰岩更是引人注目。尽管不同相带的三级沉积层序相序组构千差万变并且它们的形成时限也不尽相同，但是由其所表征的相对海平面变化则具有大致的同步性，从而在早中三叠世地层中可以识别出6个三级沉积层序；以地层记录中的两种相变面和两种穿时性为基本要素，即可以建立南盘江盆地早中三叠世的层序地层格架。早、中三叠世层序地层格架及相应的古地理特征，代表了统一的南盘江盆地的形成演化过程；晚三叠世的古地理特征，反映了南盘江盆地的消亡过程。

关 键 词：层序地层格架；古地理演化；早中三叠世；南盘江盆地
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1 引 言

早古生代末期的加里东运动使扬子板块和华夏板块基本上连接成一个统一的华南板块，但是其间华南海洋并未完全消失，在广西钦州一带残留一个著名的"钦防残留海槽"（钦州盆地；赵自强等，1996），向北还包括滇黔桂盆地和湘桂盆地等（图1,A）；从钦防海槽向北一直到"弥勒—师宗—普安断裂带" 和"紫云—罗甸—南丹—都安"断裂带，发育一个由Enos等所定义的南盘江盆地（图1,B）。随着钦防海槽在二叠纪阳新世末期由于东吴运动的影响而关闭，一直到早、中三叠世之交的印支运动初幕，代表从"滇黔桂盆地"（赵自强等，1996）到统一的南盘江盆地的转变过程，而类似于Enos等（1998）所定义的"南盘江盆地"实际上主要发育在中三叠世。因此，从时间演化的角度分析，赵自强等（1996）的沉积盆地划分方案适用于晚古生代，而Enos等（1998）的划分适用于中三叠世，两者之间的转变时期是早三叠世。前人对南盘江盆地及邻区的三叠系进行过较为深入的研究，取得了丰硕的成果。地层学方面包括杨遵仪等（2000）、赵自强等（1996）、殷保安（1997）、董卫平（1997）和张远志（1997）的系统总结；沉积岩相古地理方面包括刘宝珺等（1994）、吴应林等（1994）、冯增昭等（1997）的卓有成效的研究；20世

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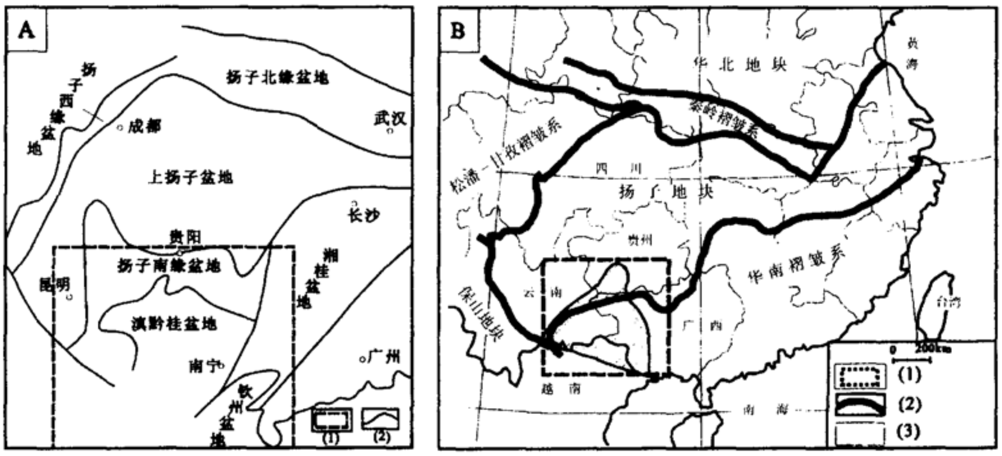


A: 赵自强等(1996)的划分方案 (division of sedimentary basins by Zhao Ziqiang et al, 1996): (1) 研究区域 (researching areas), (2) 盆地边界 (represents basin boundary); B: Enos 等(1998)的划分方案 (by Enos et al, 1998), (1) 研究区域 (the researching areas), (2) 缝合带 (suture zone), (3) 南盘江盆地 (Nanpanjiang Basin)

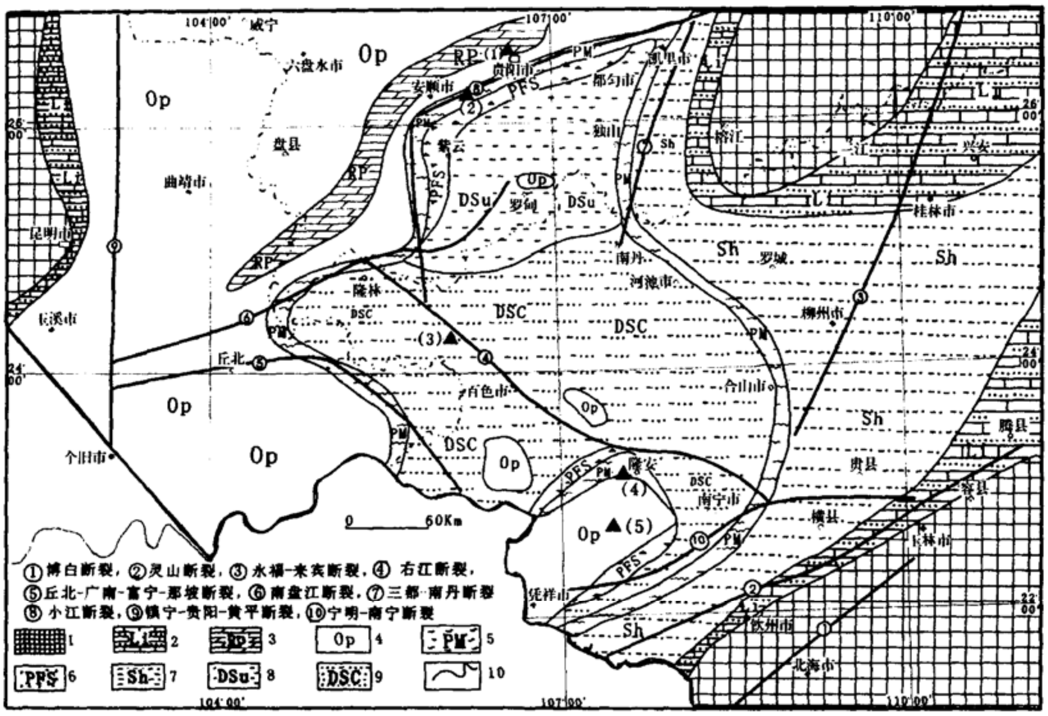
图 1 滇黔桂地区晚古生代至中三叠世沉积盆地分布图

Fig. 1 The outline map showing distribution of sedimentary basins from the Late Paleozoic to Triassic in Yunnan-Guizhou-Guangxi areas and its adjacent areas

纪 90 年代以来,牟传龙等(1991)、魏家庸等(1993)、许效松等(1994)、章正军等(1998)、殷鸿福等(1994)和梅冥相等(2002)对其层序地层进行了系统的研究。以后,梅冥相等(1994,1995,1996)认为,同震旦系与寒武系之交的淹没不整合型层序界面一样,中国南方二叠系与三叠系之交也存在一个明显的淹没不整合面,该界面作为三叠系最底部的三级层序的底界面。本文从早、中三叠世层序地层入手,较为系统地描述从滇黔桂盆地到南盘江盆地的形成、演化和消亡过程。

2 早、中三叠世层序地层格架的总体特征

对不同古地理背景的早、中三叠世剖面(图 2)的层序地层进行系统划分,分析三级沉积层序所代表的沉积物及沉积相的时间演化序列所代表的规律性,结合生物地层资料所反映的年代地层信息,即可以建立如图 3 所示的层序地层格架。从该图中可看出,虽然每一个三级层序在空间上不是等时的,但由它们所反映的时间变化过程大致是同步的;由此可以分析出在沉积相有序的时间演变过程中伴随着有规律的空间相变,只不过在不同的空间地点层序界面所指示的地层间断的幅度不同而造成三级层序的穿时性,也就是说时间过程可能是等时的但其产物就不一定等时。但是,沉积物和沉积相的时空展布所指示的规律性也具有年代地层学意义,而层序地层学本身就是去研究这种规律性,而不是为层序而层序(梅冥相等,2001)。总的来讲,早、中三叠世的 6 个三级层序即 SQ_1 至 SQ_6(图 3),代表了 6 次与三级海平变化相关的沉积环境的"加深—变浅"过程,以及连陆台地从缓坡型台地到镶嵌陆架型台地的演变过程(梅冥相等,2002)。同时,早三叠世末期的印支运动初幕,不但代表了一定规模的构造抬升,而且还伴随着较为强烈的火山活动;晚三叠世早期的印支运动主幕,使研究区结束了海相沉积的历史,造成了更大规模的古地理变迁。不同时期的层序地层格架代表了盆地充填序列的基本特



黑色三角形代表主要剖面(black triangles represent the main logged sections)；(1) 贵阳蔡家关剖面(the Caijiaguan section in Guiyang)，(2) 安顺双堡剖面(the Shuangpu section in Anshun)，(3) 田林八渡剖面(the Badu section in Tianlin)，(4) 隆安都结剖面(the Dujie section in Longan)，(5) 崇左布满剖面(the Buman section in Chongzuo)；1. 古陆(old land)；2. 混积台地(mixed platform)；3. 局限台地(restricted platform)；4. 开阔台地(open platform)；5. 台地边缘(platform margin)；6. 斜坡(slope)；7. 陆架(shelf)；8. 欠补偿盆地(undercompensational basin)；9. 浊积盆地(turbidite basin)；10. 相带界线(boundary of sedimentary-facies zones)

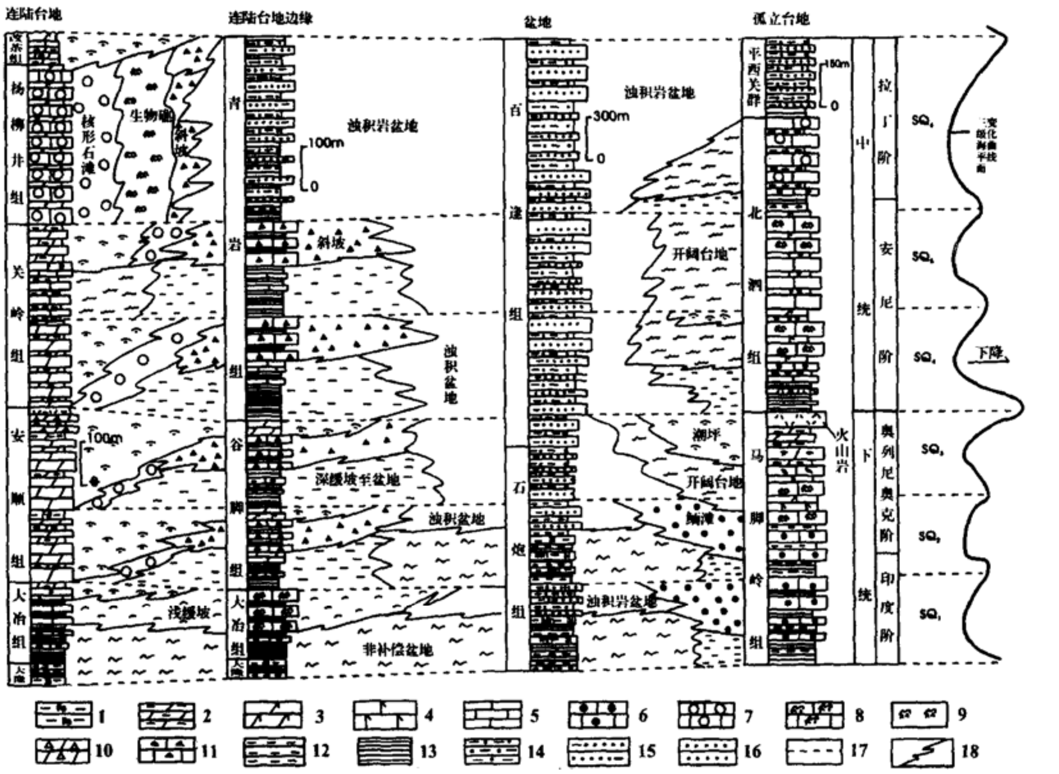
图 2　南盘江盆地及邻区中三叠世安尼期岩相古地理图

Fig. 2　The outline map showing sedimentary-facies and paleogeography of the Anisian age of the Middle Triassic in the Nanpanjiang Basin and its adjacent areas

点，与其相对应的古地理特征又更加形象地反映出层序地层格架所代表的沉积相的空间变化特征。

3　早三叠世层序地层格架及古地理特征

在研究区范围内，以早三叠世地层为主所构成的 3 个三级沉积层序 SQ_1，SQ_2 和 SQ_3，反映了 3 次与海平面升降变化相关的环境加深和变浅过程。二叠纪与三叠纪之交的大规模台地淹没事件(梅冥相等，2000)，除了在二叠系顶部的三级层序 SQ_{25} 与三叠系的 SQ_1 之间形成一个明显的淹没不整合型层序界面外，还在 SQ_1 的底部形成各地厚度不同的缺氧事件沉积地层，即贵州所称的“沙堡湾页岩”以及广西所称的“南洪页岩”，该三级层序构成一个典型的缓坡型台地，不管是连陆台地还是孤立台地均为缓坡型；SQ_2 与 SQ_3 的形成过程即代表碳酸盐台地从缓坡型向镶嵌陆架型台地转变的过程，而且层序界面所指示的暴露间断强度和幅度自下而上变大，因此在连陆台地上于 SQ_2 和 SQ_3 的顶部发育白云岩地层，连陆台地边缘于其早期



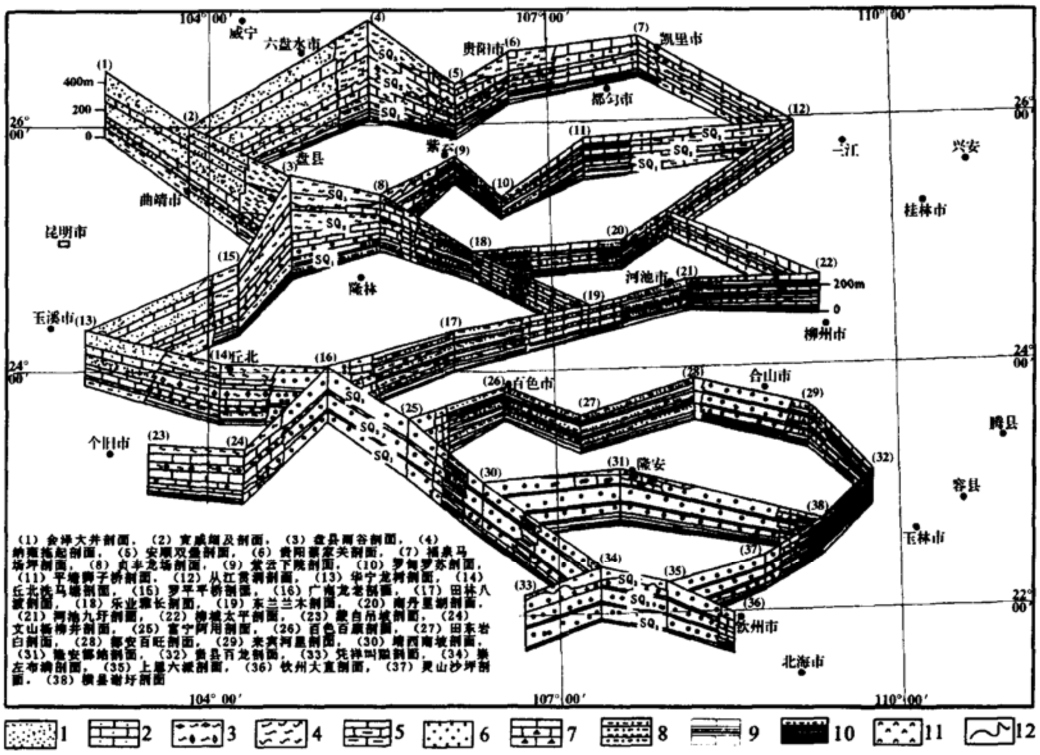
连陆台地以贵阳蔡家关剖面为代表,连陆台地边缘以安顺双堡剖面为代表,盆地以田林八渡剖面为代表,孤立台地以隆安都结剖面为代表,这些剖面的位置如图 2 所示(The typical sections that represent different sedimentary background include as follow: the attached platform is represented by the Caijiaguan section in Guiyang, the margin of attached platform is did by the Shuangpu section in Anshun, the basin is did by the Badu section in Tianlin, the isolated platform is did by the Dujie section in Long'an, and their locations are shown in Figure 2.); 岩性符号分别为(The lithological marks are as follows): 1. 古土壤层(paleosol layer); 2. 泥质白云岩(muddy dolomite); 3. 灰质白云岩(lime dolomite); 4. 白云质灰岩(dolomitic limestone); 5. 泥晶灰岩(micritic limestone); 6. 鲕粒灰岩(oolitic limestone); 7. 核形石灰岩(oncolite limestone); 8. 生物丘灰岩(bioherm limestone); 9. 生物礁灰岩(reef limestone); 10. 角砾白云岩(breccia dolomite); 11. 角砾灰岩(breccia limestone); 12. 泥岩(mudstone); 13. 页岩(shale); 14. 砂质泥岩(sandy mudstone); 15. 泥质砂岩(muddy sandstone); 16. 砂岩(sandstone); 17. 层序界面(sequence boundary); 18. 静态相变面(static facies-change surface).

图 3 南盘江盆地及邻区三叠系层序地层格架

Fig. 3 The sequence-stratigraphic framework of the Early to Middle Triassic in the Nanpanjiang Basin and its adjacent areas

高水位体系域中发育颗粒滩相灰岩,在斜坡背景中则发育塌积角砾灰岩。与此相对应的是在孤立台地上早三叠世的这 3 个三级层序的高水位体系域中发育鲕粒滩相灰岩及生物丘灰岩,在盆地中则以非补偿及欠补偿沉积为特征。所有上述演化特征均较为清楚地反映在图 4 的层序地层格架栅状图之中。

形成图 4 层序地层格架的古地理背景如图 5 所示。总的说来,二叠纪与三叠纪之交的大规模淹没事件改变了二叠纪的古地理格局,它使一些孤立台地被淹没而结束其碳酸盐台地的生长发育历史,并且由于镇宁—册亨断裂带与贵阳—黄平断裂带连在一起,从而使二叠纪的呈

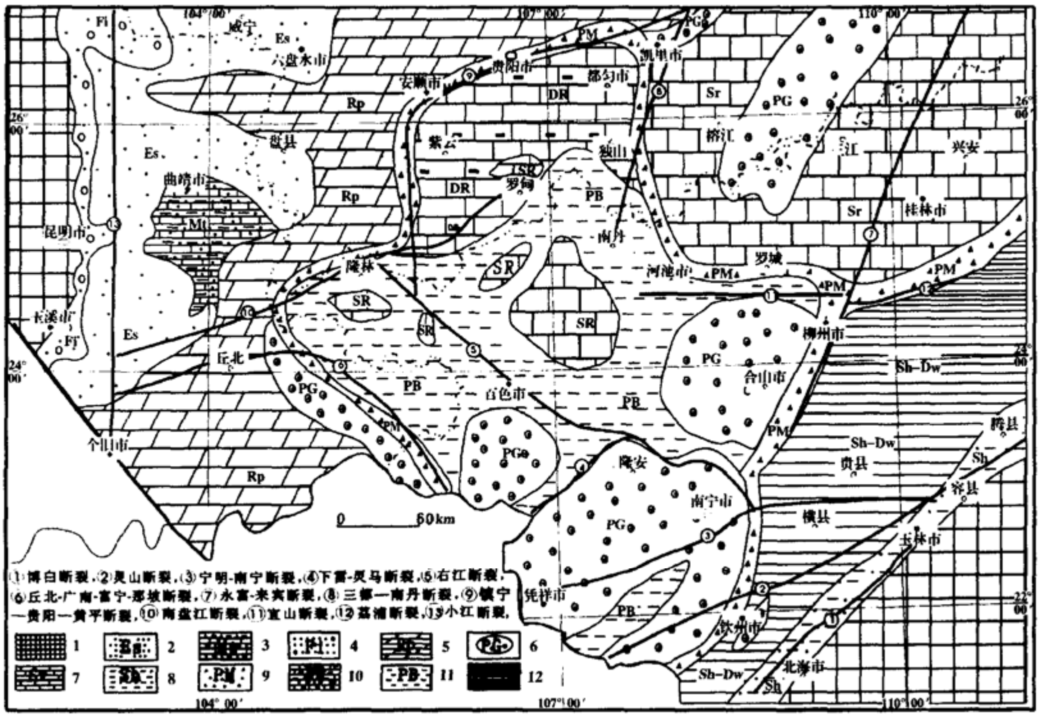


1. 滨岸相砂岩(littoral sandstone); 2. 临滨相砂质灰岩(shoreface sandylimestone); 3. 泻湖相泥岩和白云岩(lagoon mudstone and dolomite); 4. 潮坪相白云岩(tidal-flat dolomite); 5. 缓坡相泥灰岩和泥晶灰岩(ramp marl and micrite); 6. 颗粒滩相鲕粒灰岩(grain-bank oolitic limestone); 7. 斜坡相角砾灰岩(slope breccia limestone); 8. 陆架相砂质泥岩(shelf sandy limestone); 9. 深缓坡相泥页岩及泥晶灰岩(deep-ramp muddy shale and micrite); 10. 盆地相浊积岩(basin turbidite); 11. 火山岩(volcanic reck); 12. 静态相变面(static facies-changing surface)

图4　南盘江盆地早三叠世(SQ1－SQ3)层序地层格架栅状图

Fig.4　The panel diagram of sequence-stratigraphic framework from SQ_1 to SQ_3 of the Early Triassic in the Nanpanjiang Basin and its adjacent areas

不规则"S"形展布的连陆台地边缘相带向北向西迁移，在沿富宁—广南—兴义—册亨—镇宁—贵阳—黄平一线发育三叠系的连陆台地边缘相带，该相变带以东及以南则发育一个范围更广大的深水盆地，即形成了一个独特的古地理格局。早三叠世末期，伴随着区域上较为强烈的火山活动，也发生了幅度较大的海平面下降事件，即形成了印支运动初幕的区域构造不整合面——SQ_3 的顶界面。在南盘江盆地及其邻区，早三叠世的古地理背景与二叠纪相比差异性大于继承性。继承性表现为南部的孤立台地，如合山台地、靖西台地、南宁台地继续生长，和东南部呈北东向展布的湘桂盆地。差异性表现为南盘江盆地中心地带的乐业孤立台地、隆林孤立台地等被淹没并逐渐消亡，而在贵州罗甸新发育一个板庚孤立台地；连陆台地边缘的展布与二叠纪不同，总体向北迁移。更为特殊的是，南部的几个孤立台地上在早三叠世均不同程度的发育鲕粒滩，盆地相带由非补偿沉积逐渐演化为补偿沉积。因此，早三叠世统一的南盘江盆地还未形成。



1. 古陆(old land); 2. 滨海平原(littoral plain); 3. 混积台地(mixed platform); 4. 河流(river); 5. 局限台地(restricted platform); 6. 鲕粒滩(oolitic bank); 7. 浅缓坡(shallow ramp); 8. 陆架(shelf); 9. 台地边缘(platform margin); 10. 深缓坡(deep ramp); 11. 台间盆地(inter-platform basin); 12. 次深海槽(relict trough)

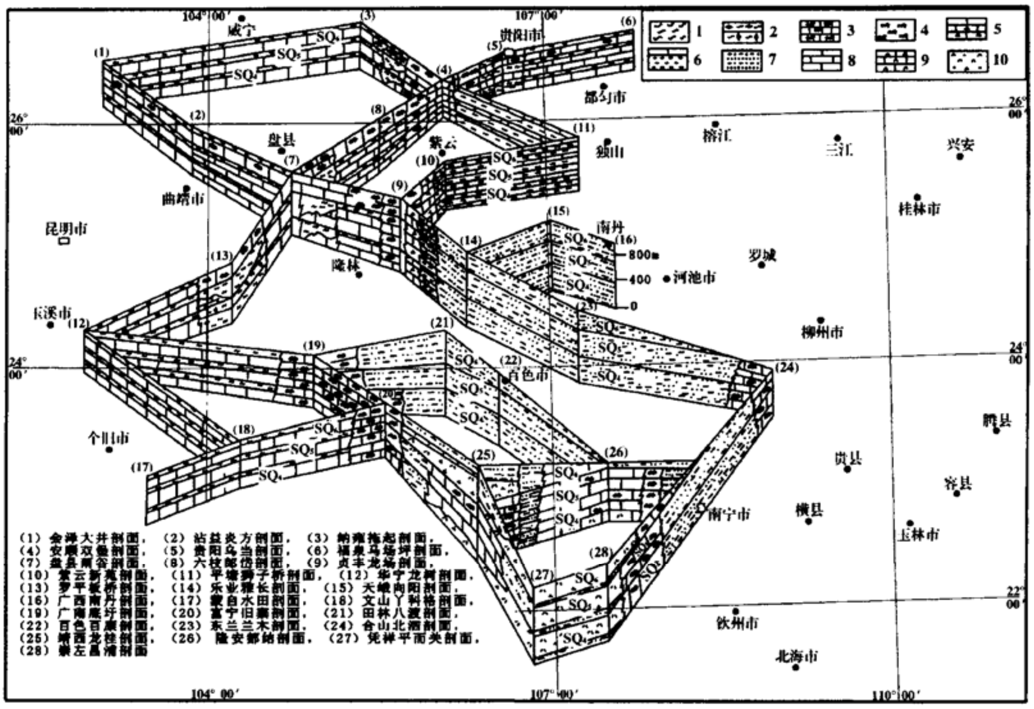
图5　南盘江盆地及邻区早三叠世岩相古地理图

Fig. 5　The outline map shows the sedimentary-facies and paleogeography of the early epoch of Triassic in the Nanpanjiang Basin and its adjacent areas

4　中三叠世层序地层格架与古地理特征

在以中三叠世地层为主所构成的3个三级层序即SQ_4，SQ_5和SQ_6中，反映了较为明显的3次环境加深和变浅过程：在与三级海平面上升相关的环境加深中，沉积相带向古陆方向迁移，形成退积序列；反之沉积相带向盆地方向迁移而形成进积序列。该时期最明显的特点是，每一个三级层序的相对海平面上升所产生的海侵幅度和强度均较大，在连陆台地边缘发育生物礁滩相灰岩的同时，盆地相中则以非补偿和次补偿型浊积岩系的广泛分布为特征，在孤立台地上则以生物丘灰岩为主；而在每一次三级海平面的停滞期和下降期，连陆台地及其边缘孤立台地上发育较多的白云岩地层，盆地中则以补偿型浊积岩系的广泛发育为特征。更为特殊的是，在南宁孤立台地的东南部发育较厚的火山岩系，强烈的火山活动可能为浊积盆地提供了丰富的物质来源，使浊积盆地变为补偿型沉积。中三叠世沉积物的时间演化序列以及沉积相的空间展布特点均较为清楚地反映在图6所示的层序地层格架栅状图之中。

中三叠世早中期发生了较大范围的海侵作用，在台地边缘及靠近台地边缘的地方在SQ_2和SQ_3的顶部发育的局限海台地相白云岩地层之上常常覆盖着中三叠SQ_4与SQ_5的灰岩地

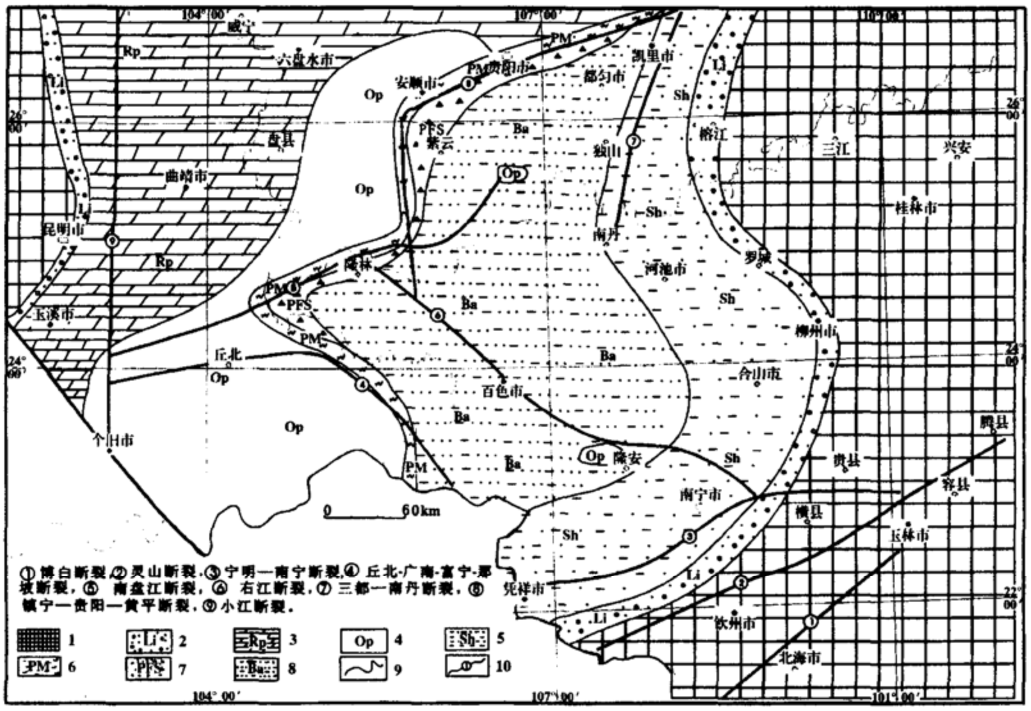


1. 潮坪相白云岩(tidal-flat dolomite)；2. 泻湖相含盐白云岩(lagoon salty dolomite)；3. 开阔台地相生物丘灰岩(open-platform bioherm limestone)；4. 生物礁灰岩(reef limestone)；5. 斜坡相角砾灰岩(slope breccia limestone)；6. 欠补偿盆地相泥岩及泥灰岩(undercompensational-basin mustone and marl)；7. 盆地相浊积岩(basin turbidity)；8. 开阔海台地相灰岩(open-platform limestone)；9. 凝灰质灰岩(tufflimestone)；10. 火山岩及凝灰岩(volcanic rock and tuff)

图6　南盘江盆地及邻区中三叠世(SQ_4-SQ_6)层序地层格架栅状图

Fig.6　The panel diagram of sequence-stratigraphic framework from SQ_4 to SQ_6 of the Middle Triassic in the Nanpanjiang Basin and its adjacent areas

层，明显的沉积相带向古陆方向的迁移也就表明了这一点。因此，SQ_4 和 SQ_5 形成时期的中三叠世安尼期(图1)，已经形成了一个统一的南盘江盆地的雏形，习称的湘桂盆地在萎缩(图1)，孤立台地的分布范围更加明显地变小；更为特殊的是，此时的南盘江盆地是一个不对称的盆地，西部边界为连陆台地边缘，而东部则以陆棚相砂泥岩与古陆相接。在SQ6形成的拉丁期，古地理背景发生了较大变化(图7)：东部较为强烈的构造抬升使习称的湘桂盆地消亡，形成了一个统一的南盘江盆地，与安尼期相似为一个不对称的盆地，该时期的盆地以补偿型浊积岩系的广泛发育为特征；该时期，浊积盆地中还残留两个小型的孤立台地，一个是广西南宁北部的南宁孤立台地，另一个是贵州罗甸北部的板庚孤立台地。不管是台地还是盆地，中三叠统的地层保留程度不同，除了十万大山地区发育侏罗系和白垩系外，其余大部分地区缺失上三叠统以上的地层，由此而说明印支运动主幕所造成的地壳抬升规模巨大而且非常突然，所反映的构造作用特征和样式也是非常特殊的。较为复杂的沉积相时间演变以及所伴随的空间相变，造成对南盘江盆地或右江盆地的盆地性质长期以来还存在若干争议，特别是三叠纪浊积盆地中较厚的浊积岩的物质来源，至今还不清楚。



1. 古陆(oldland); 2. 滨岸(littoral); 3. 局限台地(restricted platform); 4. 开阔台地(open platform); 5. 陆架(shelf); 6. 台地边缘(platform margin); 7. 斜坡(slope); 8. 浊积盆地(turbidite basin); 9. 相带界线(boundary of sedimentary-facies zone); 10. 断裂(fault)

图7 南盘江盆地及邻区中三叠世拉丁期岩相古地理图

Fig.7 The outline map showing sedimentary-facies and paleogeography of the Ladinian age of the Middle Triassic in Nanpanjiang Basin and its adjacent areas

5 晚三叠世岩相古地理特征

随着拉丁期的持续型海退,研究区的古地理格局发生了极大变化,古陆连成一片,残留海相沉积区总体向北西方向迁移(图8,图9)。晚三叠世卡尼期(图8),在南盘江盆地还保留着一个统一的浊积盆地,但是其分布面积明显变小:浊积岩系(图8:Ba)与古陆之间发育呈窄长带状展布的陆架相(图8:Sh)砂泥岩相带。在晚三叠世诺利期和瑞替期(图9),研究区域整体隆升,在西北部发育河流作用沉积,以前的浊积岩系分布区域演变为三角洲平原相(图9:D);在广西的十万大山地区,由于受断裂带强烈活动的影响形成了十万大山陆相盆地的雏形,在晚三叠世充填了厚度近6 000 m的粗碎屑陆相磨拉石沉积——平洞组和扶隆坳组。大致在卡尼期之后,同中国南方广大地区一样,研究区域结束了海相沉积的历史。

而晚三叠世的岩相古地理图(图8,图9)所反映出的南盘江盆地的消亡过程,明显地表现出东部抬升要比西部强烈,包括从早三叠世到中三叠世湘桂盆地的逐渐消亡、最终才是南盘江盆地的消亡。区域古地理的变迁明显地受到区域构造以及大地构造格局的控制,这方面还涉及到古特提斯海的演化以及古太平洋的演化问题,它已经超过本文的讨论范畴,其相关问题还有待于今后进一步研究。

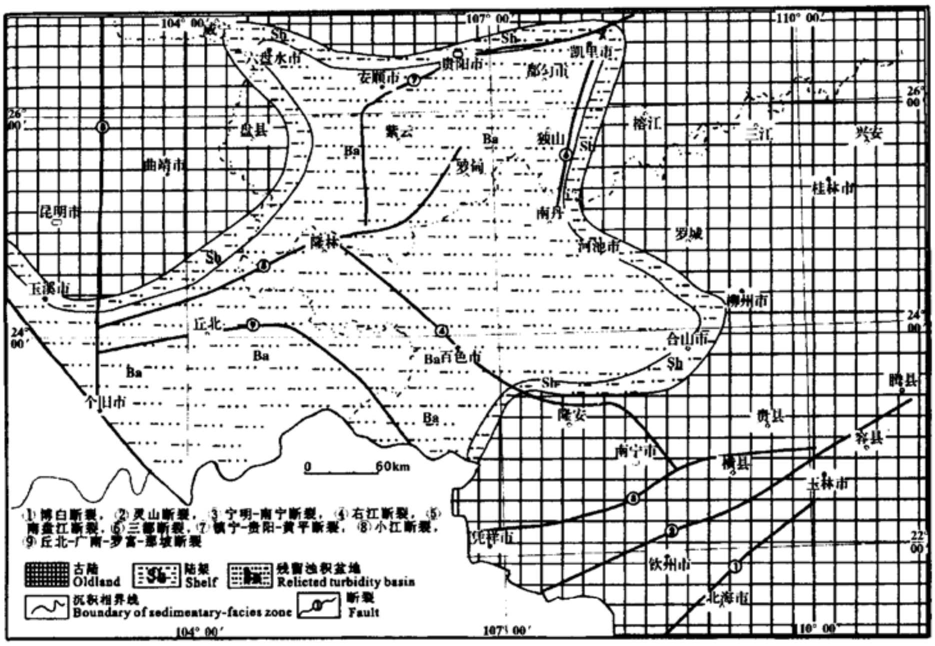


图8　南盘江盆地及邻区晚三叠世卡尼期岩相古地理图

Fig. 8　The outline map showing sedimentary-facies and paleogeography of the Canian age of the Late Triassic in the Nanpanjiang Basin and its adjacent areas

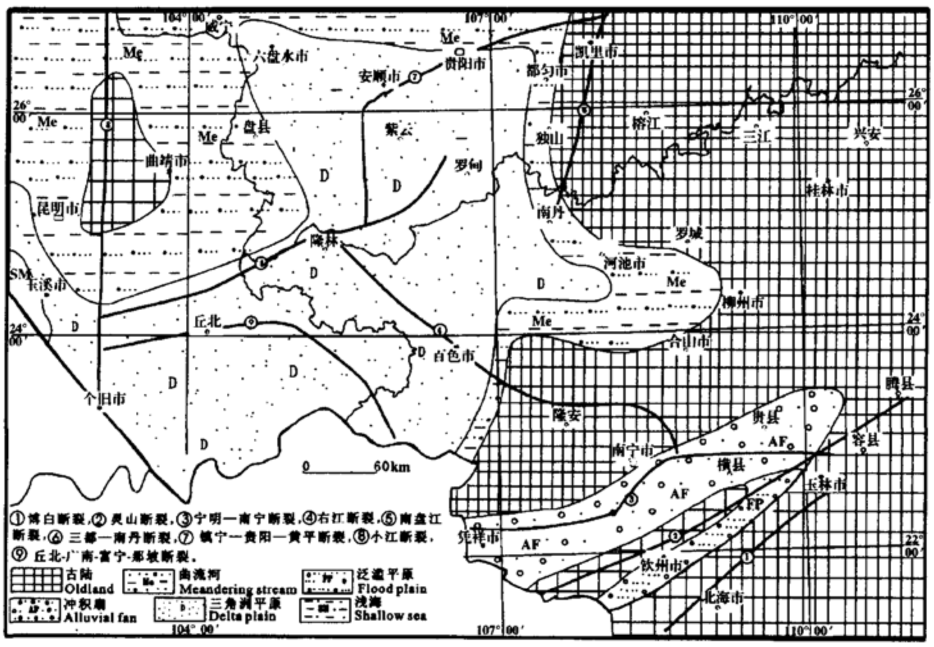


图9　南盘江盆地晚三叠世诺利期及瑞替期岩相古地理图

Fig. 9　The outline map showing sedimentary-facies and paleogeography of the Norian and Rhaetian ages of the Late Triassic in the Nanpanjiang Basin and its adjacent areas

6 结 语

三叠纪南盘江盆地经历了从海相沉积到大片古陆的演变过程,中三叠统为主的的浊积岩系地层所代表的浊积盆地的物源区至今还未定论,以致造成对其盆地性质的认识存在不同的看法(金鹤生等,1993;夏文臣等,1991;吴应林等,1990;陈洪德等(1991))。同中国南方的其它广大地区一样,强烈的印支运动使研究区域结束了海相沉积的历史;早三叠世到中三叠世,碳酸盐台地由缓坡型演变为镶嵌陆架型,本身就代表了二叠纪－三叠纪之交的大规模生物灭绝事件之后的特殊的沉积学响应。再者,南盘江盆地早中三叠世的三级海平面变化旋回与欧洲三叠纪同时代的三级海平面变化旋回(Goldhammer et al,1990;Aigner et al,1992)也不尽相同,这可能是区域构造运动影响的结果。因此,作者只是在对沉积物的时间演化序列和沉积相的空间展布形式进行大致描述的基础上,对南盘江盆地的形成演变与消亡过程进行初步描述,其中还存在许多有待于进一步研究的问题。

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Sequence-Stratigraphic Framework of the Early to Middle Triassic and Evolution of Sedimentary-Facies and Paleogeography in the Nanpanjiang Basin and Its Adjacent Areas: Discussion on Evolutionary Process from the Dianqiangui Basin to the Nanpanjiang Basin

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Abstract: A large-scale drowning event occurred in the transitional period between the Permian and the Triassic and resulted in the demise of some carbonate platforms in the Nanpanjiang Basin and its adjacent areas. The research areas experienced an evolutionary process of sedimentary basin from the Dianqiangui Basin to the Nanpanjiang Basin in the Triassic. Accordingly, the Triassic period is a differential period of sedimentary facies in the research areas, which are marked by the spatial changes from the connective platforms to the turbidity basin with the development of the several isolated platforms. More particularly, oolitic banks of the early epoch are developed in some isolated platforms such as in the Jingxi platform and in the Nanning platform in the southern part of the Nanpanjiang Basin. Same as the limestones of reef and beach in the margin of the attached platform, the limestones of oolitic banks in isolated platforms came to front. Despite the differences in the time-span and the architecture of facies-succession of third-order sedimentary sequences, the process of the third-order relative sea-level changes reflected by the sedimentary-facies succession is generally synchronous. Therefore, six third-order sequences could be discerned in the Early and the Middle Triassic in the Nanpanjiang Basin. With the two types of facies-changing surfaces and two types of diachronisms in stratigraphic records as the key elements, the framework of sequence stratigraphy from the Early to the Middle Triassic in the Nanpanjiang Basin could be constructed. The sequence-stratigraphic framework and the relevant paleogeographical features of the Early to Middle Triassic reveal the formational and the evolutionary process of the Nanpanjiang Basin, and the paleogeographical features of the Late Triassic reflect the dying of the Nanpanjiang Basin.

In the research areas, the Early Triassic can be grouped into three third-order sequences,

SQ_1, SQ_2 and SQ_3. The forming process of SQ_1 represents a building process of a ramp carbonate platform not only in the attached platform but also in the isolated platform. The forming process of SQ_2 and SQ_3 reflects an evolutionary process of the carbonate platform from the ramp type to the rimmed-shelf type. Correspondingly, oolitic-bank limestones constitute the HSTs from SQ_1 to SQ_3 in the background of an isolated platform. A succession from the non-compensatory sediments to the compensatory sediments of turbidity basin is formed in the settings of a deep-water basin.

Three third-order sequences from SQ_4 to SQ_6 of the Middle Triassic reflect three obvious changing processes in the deepening-shoaling of sedimentary environment. Consequently, turbidity rock-series are formed in the setting of a basin; reef limestones or bank limestones are developed in the margin of attached platform, and bioherm limestones are formed in isolated platforms.

In the transitional period between the Early and Middle Triassic, in concomitance with the strong volcanic activity, there was a large-scope fall of third-order sea level changes, which generated the unconformity of the first episode of the Indosinian movement—the top boundary of SQ_3. With the rise of the crust caused by Indosinian movement in the east part of the research area, "the Xianggui Basin" is defined by Zhao et al. (1996) was gradually closed, thus a unified turbidity basin i.e, "the Nanpanjiang Basin" defined by Enos et al. (1998) was formed in the Ladinian age in the Dianqiangui area.

Key words: sequence-stratigraphic framework; evolutionary process of paleogeography; Early to Middle Triassic; Nanpanjiang Basin.

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