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青海南部二叠纪籤类生物古地理区系

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摘要:冈瓦纳与欧亚大陆间的昌都地块构造属性存在争议,解决问题的关键是生物古地理区系判别.青海南部二叠纪籤类化石群的研究表明昌都地块该生物群一直表现为暖水的特提斯型,与华南地区始终表现出更多的相似性,其生物古地理归属应为特提斯大区华夏-特提斯区华南亚区.昌都地块南界龙木错-双湖-澜沧江缝合带在早二叠世为划分青藏高原暖水型特提斯区的南界,不仅是华南亚区与藏北冷暖混合亚区的分界线,也是特提斯大区与冈瓦纳大区的分界线.中二叠世以后该带不再构成大区界线,但在确定次一级分区界线上仍是一个很好的划分标志;北界金沙江缝合带二叠纪两侧生物群表现出一致性,未形成浅海底栖生物自由迁移的障碍,不具有生物古地理分区意义.

关键词:昌都地块;二叠纪;籤类;古生物地理;地理分布;地层学.

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Palaeobiogeography of Permian Fusulinid in Southern Qinghai

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Abstract: The tectonic affiliation of Qamdo Block between the Gondwana and Eurasia remains controversial, which involves mainly the determination of the northern boundary of Gondwana and the palaeobiogeography of Qamdo Block. Fusulinid fauna, a kind of benthic life, is applied to the palaeobiogeography study in this paper. Based on abundant of fusulinid fossils from Early Permian *Schwagerina cushmani* fauna to Late Permian *Palaeofusulina sinensis* fauna in volcano-sedimentary sequences from southern Qinghai, it is proposed these fusulinid faunas have always been the warm-water Tethyan type, showing more similarity with the counterpart from South China, and has not been linked to the fauna from the Gondwana. The fusulinids from the Qamdo Block should belong to the South China Subprovince, Cathaysian-Tethyan Province, Tethyan Realm in palaeobiogeographic affiliation. The Lungmu Co-Shuanghu-Lantsangjiang Suture Zone in the Early Permian is proposed as the southern boundary of the Cathaysian-Tethyan Province (warm-water type) in the Tibetan Plateau (or the boundary of South China Subprovince and the northern Tibet Subprovince characterized by a mixed warm and cold biota). This suture zone is the division between Tethyan and Gondwana Realms which was changed in the Middle and Late Permian and can not be regarded as the boundary of Realms, although a minor difference between the fusulinid faunas from two areas separated by the suture zone still existed.Furthermore, the similarity of the faunas from both sides of Jinshajiang Suture Zone shows the zone is not the barrier zone which prevented the migration of benthic biota and can not be regarded as the boundary of palaeobiogeographic provinces.

Key words: Qamdo Block; Permian; fusulinid; palaeobiogeography; geographical distribution; stratigraphy.

晚古生代昌都地块位于冈瓦纳大陆与欧亚大陆之间,构造归属存在较多争议,其核心是冈瓦纳北界问题,这条分界线存在有班公湖-怒江带(刘广才和田琪,1991;潘桂棠等,1997)、龙木错-双湖-澜沧江带(李才等,1995;Metcalfe,2002;李才,2008)、金沙江带(刘训等,1992;尹集祥,1997)以及龙木错-

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金沙江带(赵政璋等,2001)等不同认识,而解决此问题的一个关键是对昌都地块生物古地理区系的判别.研究表明,二叠纪青藏高原存在着冈瓦纳冷温型和华夏暖温型动、植物群及它们的混合生物群.一般把冷暖生物群的分界定义为冈瓦纳与特提斯生物古地理区的划分界线,也有学者注意到二叠纪冷、暖型动、植物地理区系发生的变化,聂泽同和宋志敏(1990)提出两大块体界线早中二叠世为金沙江带,晚二叠世则为班公湖－怒江带,这些界线均集中于昌都地块周边,因而昌都地块生物古地理区系的确定尤显重要.

青海南部唐古拉山至治多、杂多地区处于金沙江结合带与澜沧江结合带间的昌都地块中部(任纪舜等,1999),二叠系出露广泛,火山活动十分强烈,火山岩分布广,厚度大,相变快,在火山喷发的间歇期沉积碳酸盐岩、碎屑岩.其中碳酸盐岩中产丰富的籤类化石,自早二叠世 *Schwagerina cushmani* 动物群至晚二叠世 *Palaeofusulina sinensis* 动物群均有见到(Niu *et al*.,2008).

籤类动物群的分布不仅受温度,而且也受热带、亚热带或暖温带地理位置的控制(Ross,1967),因而被用于生物古地理研究(Leven,1997;Ueno and Igo,1997;Kobayashi,1999;Belasky *et al*.,2002;Villa and Ueno,2002;Beccaletto *et al*.,2005).Ross(1967)较早地研究了二叠纪籤类生物地理分区,盛金章和王玉净(1981)首先系统阐明了二叠纪籤类动物地理区系,将其分为 2 个区系:北极大区和特提斯大区,并将后者又分为 3 个区:冈瓦纳－特提斯区、安加拉－特提斯区和华夏－特提斯区.在此基础上周建平等(2000)将华夏－特提斯区再细分为华南亚区、华北亚区、西北亚区.

笔者近些年来在青海南部进行地质调查与研究工作,获得了较多以籤类为主的古生物学及沉积岩、火山岩地球化学、同位素地球化学等方面的第一手资料,本文旨在通过这些籤类化石的研究来探讨二叠纪青海南部所在的昌都地块生物的古地理属性.

1　研究方法简述

生物古地理学主要研究古代生物的起源、分布及演化发展历史.生物古地理学的研究,对于再造古海洋及古板块的演化历史具有重要意义,目前主要有 3 个研究方向,即生态生物古地理、分类生物古地理和谱系或历史生物古地理.本文研究采用的是分类生物古地理.在研究方法上,采用"属"或"亚属"为划分基础对比昌都地块与相邻地区生物古地理分区关系,划分方案采用大区、区和亚区三级名称.

近年来,生物古地理分区不再仅仅根据某些门类中某几个特征属的存在与否而定性地划分,而是进行比较精确的定量分析、公式计算,统计出各个生物地理分区之间的相似系数,目前通常采用大冢相似系数,并通过数理统计分析图,最终判断各地区生物古地理区系的归属.殷鸿福等(1988)较早地系统应用定量分析方法对全国寒武纪以来生物古地理区系进行了系统划分.在各门类化石中,腕足类较为成功地被用于全球生物古地理分区的研究,尤其是近年来与数学统计方法相结合,对生物古地理分区进行定量化(Bambach,1990;Shi and Archbold,1996;Shi,2006;Shen and Shi,2000,2004).

二叠系籤类属的数量相对较少,早二叠世(乌拉尔世)我国有 25 属(亚属)、中二叠世(瓜德鲁普世)56 属(亚属)、晚二叠世(乐平世)13 属(亚属)(周建平等,2000),目前在国内尚无系统的生物古地理区系定量研究.由于研究区二叠纪籤类动物群与相邻地区在属一级上差别不大,大冢相似系数无代表意义,生物古地理区系研究仍然侧重于动物群"属"级的对比及具有重要划分标志的籤类化石的有或无.

2　早二叠世(乌拉尔世)

研究区石炭纪产少量的籤类化石,生物群特征显示出以华南地区化石为主,混有少量欧洲区化石,与位于龙木错－双湖－澜沧江结合带以北的塔里木盆地、华南、龙门山、西秦岭同属于暖水的华夏－特提斯区(牛志军等,2005).二叠纪继承了石炭纪的特征,全球生物群具有三分性,即南北两极为冷温型,中部为暖温型的特点,但期间全球气候经历了一个由冷至暖的过程,必然影响到生物古地理区系的变化.

早二叠世早期是青藏高原冷、暖生物群分异最为明显的时期,籤类是对环境较为敏感的一种生物,这势必使其生物群属种组成、生态特征、地理分布等方面发生改变,而此时期则是确定昌都地块生物古地理归属的关键点.

青海南部沱沱河地区二叠系底部扎日根组的籤类计有 *Zellina*, *Boultonia*, *Montiparus*, *Robustoschwagerina*, *Sphaeroschwagerina*, *Toriyamaia*, *Pisolina*, *Schwagerina*, *Staffella*, *Sphaerulina*,

Nankinella, *Pamirina*, *Pseudoendothyra* 等属(刘广才和田琪,1993),最近笔者在该沱沱河南部开心岭一带扎日根组采获籤类化石:*Eopara fusulina* (*Mccloudia*), *Schubertella*, *Pseudoschwagerina*, *Zellia*, *Sphaeroschwagerina*, *Triticites*, *Nankinella*,青海省地质调查院在该地区的区调工作中发现 *Eopara fusulina*, *Quasi fusulina*, *Sphaeroschwagerina*, *Chalaroschwagerina*, *Rugoso fusulina*, *Zellia*, *Triticites*, *Pseudoendothyra*, *Schubertella*, *Pseudoschwagerina*, *Pseudo fusulina*, *Schwagerina*, *Para fusulina*, *Misellina*, *Brevaxina* 等属(青海省地质调查院,青海 1∶25 万沱沱河幅区域地质调查报告,2006),这些都是华南地区下二叠统紫松阶至罗甸阶下部的常见化石,明确地显示出特提斯区系特征.

治多—杂多一带罗甸期籤类 *Misellina* 带中,计有 *Ozawainella*, *Dunbarula*, *Pisolina*, *Schubertella*, *Toriyamaia*, *Minojapanella*, *Wutuella*, *Kahlerina*, *Yangchienia*, *Nankinella*, *Sphaerulina*, *Schwagerina*, *Para fusulina*, *Pseudo fusulina*, *Misellina* 等,较为特征的是拟旋脊发育的 *Misellina* 属(牛志军等,2010),这些属均为早二叠世华夏陆块群海域的主要生物化石,与珊瑚等一起组成暖水型生物群,而且具暖水型特征的生物群向北向东跨越金沙江结合带,青海南部阿尼玛卿地区的树门维科组(青海省地质矿产局,1991)、阿尼玛卿蛇绿岩带的推覆体(Pospeloy *et al*.,2005)、川西的中咱地块冰峰组(张遴信,1982)等籤类动物群(图 1)均为暖水特提斯型.

然而暖水型 *Misellina* 动物群却未能向南跨越龙木错—双湖—澜沧江结合带(图 1),该带以南的羌塘地块为以籤类 *Monodiexodina* 动物群为特征的冷温型生物群(聂泽同和宋志敏,1983a,1983b,1983c;尹集祥,1997).近年来在龙木错—双湖—澜沧江一线以北的东昆仑木孜塔格地区发现了冈瓦纳冷温型籤类 *Monodiexodina* 动物群(孙巧缡和马华东,2002;王秉璋等,2002)(图 1 中格尔木西部的两个点),尹福光等(2005)研究后认为含 *Monodiexodina* 的岩石为浊流与喷溢流等异地成因,并非原地沉积的生物群,与其共生的原地生物组合为籤类 *Misellina* 动物群及珊瑚礁灰岩等,即背景沉积的生物群仍属暖水型.

为更好对比青海南部早二叠世籤类生物群与相邻地区在"属"级组成的差异,笔者选择新疆空喀山口地区(孙巧缡和张遴信,1988)、澜沧江结合带以南的羌塘地块阿里地区(杨遵仪和聂泽同,1990;张遴信,1991)、金沙江带以东的中咱地块(张遴信,1982)、西秦岭(曾学鲁等,1996)和黔南地区(肖伟民等,1986)与研究区对比.上述几个地区,空喀山口地区的资料相对较少,而且此地 *Misellina* 属与 *Monodiexodina* 属同时存在,这可能与邻近龙木错—双湖—澜沧江缝合带有关.

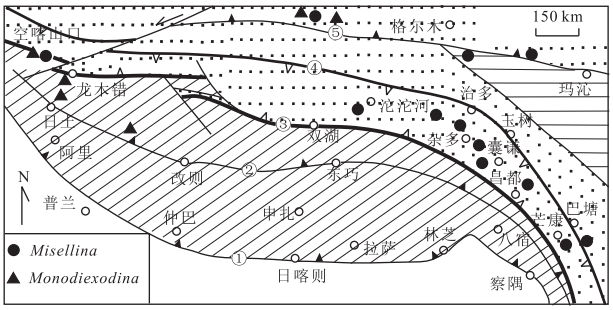

图 1 早二叠世籤类 *Misellina*(暖水型),*Monodiexodina*(冷温型)的地理分布

Fig. 1 Distribution of Early Permian genera *Misellina* (warm-water type) and *Monodiexodina* (cold-water type)

①印度斯—雅鲁藏布江缝合带;②班公湖—怒江缝合带;③龙木错—双湖—澜沧江缝合带;④金沙江缝合带;⑤昆仑—秦岭缝合带;据李才等,1995

通过研究区与相邻地区具有相同籤类化石属数量的统计分析(表 1)及属种构成对比(图 2)可以看出,龙木错—双湖—澜沧江缝合带以北地区籤类化石多超过 20 属,而该缝合带以南的阿里及临近结合带的空喀山地区籤类属较少.在 6 个地区中,阿里地区 Schwagerininae 亚科的属数量最多(图 2 红色区),达到总属数的 53%,包括具有环境指示意义的 *Monodiexodina* 属.其他地区表现出共性的是 Schwagerininae亚科约占17%～29%;Pseudos-

表 1 研究区及相邻地区早二叠世籤类生物群属级数量对比

Table 1 Comparison of generic quantity of Early Permian fusulinid fauna between South Qinghai and adjacent areas

	研究区	阿里	空喀山	藏东	西秦岭	黔南
研究区	25	10	9	17	15	12
阿里		15	8	11	9	7
空喀山			13	10	11	8
藏东				25	16	13
西秦岭					27	17
黔南						24

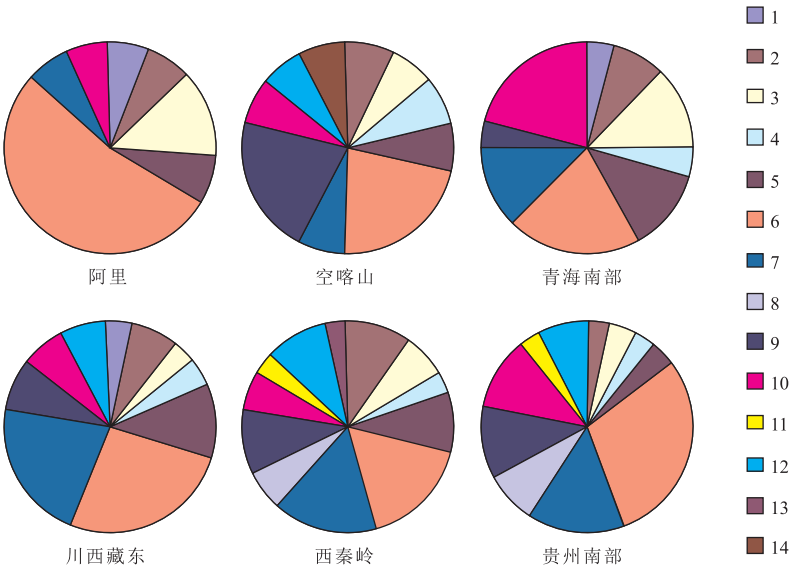

图 2　研究区与相邻地区早二叠世籤类动物群属种构成对比

Fig.2　Comparison of generic compositions of Early Permian fusulinid faunas between South Qinghai and adjacent areas

1.Ozawainellinae;2.Schubertellinae;3.Boultoniinae;4.Fusulinellinae;5.Staffellinae;6.Schwagerininae;7.Pseudoschwagerininae;8.Verbeekininae;9.Miselllininae;10.Kahlerininae;11.Eofusulininae;12.Neoschwagerininae;13.Sumatrininae;14.Polydiexodininae

chwagerininae 亚科除阿里和空喀山地区(7%)较低外,其余 4 个地区为 13%～22%;Misellininae 亚科除空喀山地区(22%)较高外,其余 4 个地区为4%～11%.青海南部地区与只产籤类 *Misellina* 动物群的川西藏东、西秦岭和黔南地区表现出更多的相似性,与阿里、空喀山地区差异略大.

3　中二叠世(瓜德鲁普世)

青海南部沱沱河地区九十道班组产籤类 *Yabeina*, *Neoschwagerina*, *Sumatrina*, *Pseudodoliolina*, *Verbeekina*, *Schwagerina*, *Chusenella*, *Dunbarula*, *Pseudofusulina* 等(刘广才和田琪,1993),笔者在治多－杂多地区九十道班组发现 *Afghanella*, *Neoschwagerina*, *Sumatrina*, *Ozawainella*, *Schubertella*, *Toriyamaia*, *Dunbarula*, *Minojapanella*, *Wutuella*, *Codonofusiella*, *Russiella*, *Yangchienia*, *Nankinella*, *Pseudoendothyra*, *Pseudofusulina*, *Parafusulina*, *Schwagerina*, *Chusenella*, *Verbeekina*, *Paraverbeekina*, *Pseudodolilolina*, *Kahlerina*, *Sphaerulina*, *Cancellina* 等 24 属,尽管未见有 *Yabeina* 属,但所有属均见于华南地区,而此时暖水的特提斯属种除见于昌都地块及金沙江带以北地区外,与早二叠世不同的是,其向南跨越龙木错－双湖－澜沧江结合带,在拉萨地块申扎(朱秀芳,1982a;王玉净和周建平,1986;黄浩等,2007;Zhang *et al*., 2010)、林周(王玉净等,1981;朱秀芳,1982b)、羌塘地块阿里地区(聂泽同和宋志敏,1983a,1983b,1983c;杨遵仪和聂泽同,1990;张遴信,1991)及印度斯－雅鲁藏布江缝合带北部(王玉净等,1981)均见有 *Neoschwagerina* 动物群,籤类属种达到空前繁盛,生物群组成上以 *Neoschwagerina*, *Chusenella* 属为主,中二叠世晚期的 *Yabeina* 属则分布较为局限(图 3).

尽管如此,通过对比青海南部与华南、拉萨地块的申扎地区(黄浩等,2007)中二叠世籤类动物群"属"的构成,其仍可见差异点(图 4).从图 4 可以看出,青海南部、华南在属的构成上相似性大,差异性小,总体上表现出除 Schubertellidae, Verbeekinidae

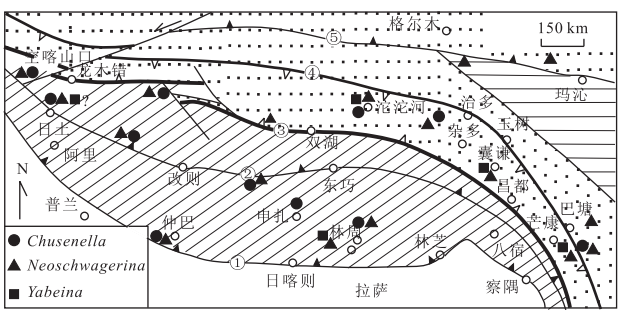

图 3　中二叠世籤类 *Neoschwagerina* 动物群的地理分布

Fig.3　Distribution of Middle Permian *Neoschwagerina* fauna

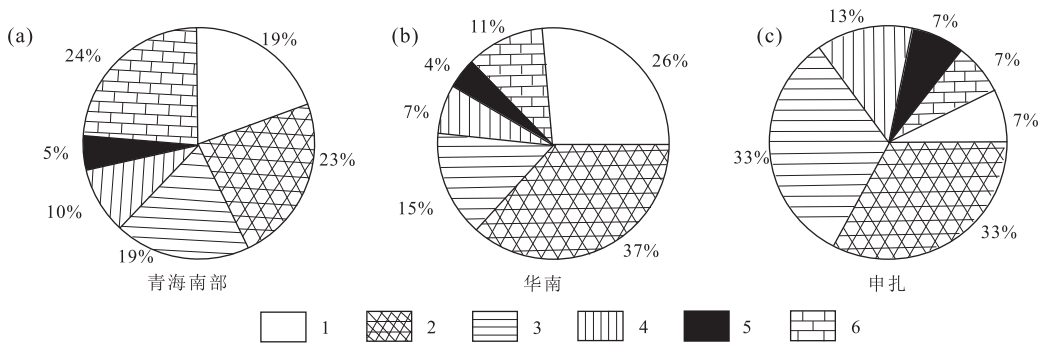

图 4 中二叠世青海南部与相邻地区籤类动物群属级构成对比

Fig.4 Comparison of generic compositions of Middle Permian fusulinid faunas from southern Qinghai and adjacent area

1.Neoschwagerinidae;2.Verbeekinidae;3.Schwagerinidae;4.Fusulinidae;5.Ozawainenellidae;6.Schubertellidae;b,c 据黄浩等(2007)

科外,其他 4 个科所占比例大体相近,尤其是中二叠世占重要地位的 Neoschwagerinidae,Schwagerinidae 科表现更多的相似性,与申扎地区则差异明显,后者 Neoschwagerinidae 科少见(仅 7%),而 Verbeekinidae,Schwagerinidae 科却相对丰富(合计达 66%),以籤类 *Chusenella*,*Nankinella* 属占优势地位,由此可见,青海南部、华南与申扎地区中二叠世籤类在种的构成及优势类群上差异也很显著.这表明即使暖水型籤类生物群在中二叠世已向南拓展至印度斯—雅鲁藏布江缝合带以北,龙木错—双湖—澜沧江结合带在区分冷、暖水型生物群的作用已不存在,但该带在确定中二叠世籤类生物古地理区系仍起着重要作用,即可作为次一级古地理分区的划分标志.

4 晚二叠世(乐平世)

青海各拉丹冬晚二叠世乌丽群可划分为 2 个化石带:*Nanlingella simplex-Palaeofusulina parafusiformis* 带和 *Gallowayinella meitienensis-Palaeofusulina sinensis* 带,产 *Nanlingella*,*Palaeofusulina*, *Parananlingella*, *Reichelina*, *Gallowayinella* 等属(牛志军等,2004).各拉丹冬以北纳保仁陇见 *Reichelina*, *Palaeofusulina*, *Codonofusiella*,*Dunbarula*,*Gallowayinella* 属(赵兵等,2006).在沱沱河一带产籤类 *Palaeofusulina*, *Reichelina*, *Nankinella*, *Spharulina*, *Eoverbeekina*,*Staffella* 等属(刘广才和田琪,1993),可以看出其可与华南地区很好地进行对比.

目前羌塘及昌都地区的晚二叠世籤类化石报道的有 9 处,即(1)川西藏东地区的四川巴塘县中咱区格马扎普、木里县唐央、稻城县罗河和西藏昌都妥坝、芒康县小邦达区(张遴信,1982);(2)青海沱沱河(刘广才和田琪,1993;沙金庚,1995)、蛇形沟地区(沙金庚等,1992);(3)西藏双湖地区热觉查卡一带(王玉净等,1981);(4)西藏日土县清水河—热河盘地区(孙东立和徐均涛,1991);(5)西藏阿里地区(杨遵仪和聂泽同,1990);(6)西藏改则县下东乡桑曲河畔(Chen *et al*.,1999);(7)各拉丹冬地区及其以北地区(牛志军等,2004;赵兵等,2006);(8)青海乌兰乌拉湖(赵兵等,2006);(9)青海囊谦岗作涌(中国地质科学院成都地质矿产研究所和四川省地质矿产局区域地质调查大队,1992).

晚二叠世 *Gallowayinella* 属地质历程短,层位十分稳定,地理分布主要见于秦岭以南地区,东至江浙一带,向西在青藏高原仅见于上述(1)、(7)、(9)处(图 5).从目前的资料来看,该属并未向南跨越龙木错—双湖—澜沧江结合带一线.

Palaeofusulina 属在地理分布上范围相对略广一些,见于中国南方、东南亚地区、南斯拉夫、俄罗斯北高加索及日本北上山地(Kobayashi,1999)等上二叠统.在青藏高原,除上述的(5)、(6)地点外均有见及(图 5),但(4)处目前仅见属名,未鉴定至种且未见图影.Kobayashi(1999)认为产于喜马拉雅地区 Lamayuru 的一个不完整标本 *Palaeofusulina* aff. *mutabilis* 的鉴定有问题.从目前的资料来看,较为肯定的是 *Palaeofusulina* 属产地也见于龙木错—双湖—澜沧江结合带一线以东以北地区.作为晚二叠世最重要的化石,Kobayashi(1999)认为 *Palaeofusulina* 动物群的出现实际上受古地理控制,这对于解释东亚与东南亚产 *Palaeofusulina* 动物群的地块提供了重要的古地理和动物学资料.Jenney and Stampfli(2000)认为 *Palaeofusulina* 属仅见于特提

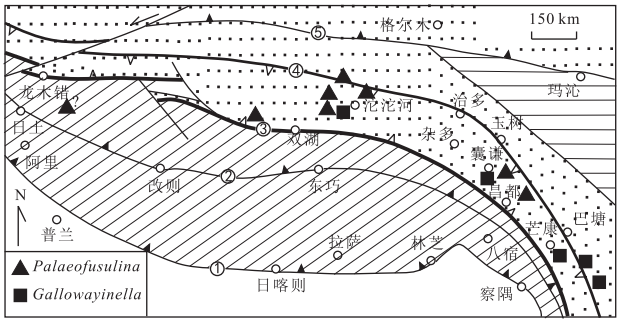

图 5　晚二叠世籤类 *Palaeofusulina*,*Gallowayinella* 属的地理分布

Fig.5　Distribution of Late Permian Genera *Palaeofusulina* and *Gallowayinella*

斯区,尤其是在北部边缘最为常见.据沙金庚等(1992)报道,与晚二叠世 *Codonofusiella lui* 带和 *Palaeofusulina sinensis* 带共生的有孔虫 *Colaniella-Baishalina pulchra reitlingerae* 和 *Paraglobivalvulina piyasini-Hemigordius irregulariformis* 组合,也主要沿着特提斯边缘分布.

需要说明的是,在龙木错－双湖－澜沧江结合带以南措勤地区发现籤类 *Reichelina* 属和有孔虫 *Colaniella* 属(陈清华等,1998;张以春和沈树忠,2007),申扎木纠错地区籤类 *Codonofusiella* 属(张予杰等,2014),这表明暖水型动物群可能向南跨越了龙木错－双湖－澜沧江结合带,但未见典型的 *Palaeofusulina* 属,其原因需要更详细的研究.

5　讨论与结论

除上述籤类外,昌都地块石炭纪至二叠纪珊瑚、腕足类生物群也可与华南地区很好地对比.He *et al*.(2008,2009)研究指出,青海南部杂多、治多地区二叠纪腕足类与华南同期腕足类具有较大的相似性,70%以上的物种均在华南出现.综合上述,笔者认为昌都地块在二叠纪籤类生物群表现为暖水的特提斯型,未见冷温型生物,以及二者的过渡类型,也未见热带与温凉带生物交替或混生的现象,尹集祥(1997)认为青海南部属于中间过渡陆块的北区,受冈瓦纳动物群影响较小.周建平等(2000)在划分中国二叠纪籤类生物古地理分区时认为西藏北部至昌都地区属于冈瓦纳古陆东北缘,为冈瓦纳边缘海域,然而青海南部地区二叠纪以籤类为主的生物群未显示出与冈瓦纳有关的信息,相反与特提斯华南地区始终表现出更多的相似性,具亲扬子性的特点,揭示出其大地构造位置应归属于特提斯区.

青藏高原二叠纪生物古地理分区前人已有较多相关论述,周建平等(2000)将中国二叠纪籤类生物群分出 3 个不同的生物古地理区:(1)华夏－特提斯区(华南亚区、华北亚区、西北亚区),(2)安加拉特提斯区(内蒙古－东北区),(3)冈瓦纳特提斯区(青藏－滇西区),后者再被分为藏东温暖亚区和藏北冷暖混合亚区.藏东温暖亚区包括西藏东部的昌都－芒康一带、澜沧江以北及滇西保山、腾冲地区,从地理位置上看,昌都地块似应划入藏东温暖亚区,但前文研究表明该区大地构造并非属于冈瓦纳区,鉴于藏东温暖亚区动物群面貌与华夏－特提斯区一致,笔者认为该亚区应归属为华夏－特提斯区,同时与华南亚区(周建平等,2000)特征相同,故没必要单独划分出来.

综合上述,笔者认为昌都地块生物古地理区系属特提斯大区华夏－特提斯区华南亚区(图 6),龙木错－双湖－澜沧江结合带在划分青藏高原整个二叠纪生物古地理分区上具有重要作用,早二叠世为划分青藏高原暖水型特提斯区的南部边界,它不仅是华南亚区与藏北冷暖混合亚区的划分界线,同时也是更高级别的特提斯大区与冈瓦纳大区的划分界线.中二叠世以后,随着暖水型特提斯生物群的南扩,该带不再构成大区界线,但其南北两侧的暖水型生物群仍存在一定的差异,揭示出该带在确定中－晚二叠世籤类生物古地理区系的亚区界线上是一个很好的划分标志.相反昌都地块北部边界的金沙江缝合带石炭纪－二叠纪两侧生物群表现出的一致性,表明该带未形成浅海底栖生物自由迁移的障碍.此外,笔者在治多县扎河地区通天河蛇绿混杂岩中发现硅质岩构造岩块,地球化学特征表现为被动大陆边缘上形成的陆间洋盆环境(段其发等,2006),也佐证了金沙江缝合带不具有生物古地理分区意义.

生物古地理区系的变化与大地构造演化密切相关.昌都地块晚古生代经历了古特提斯的构造演化阶段,即从华夏陆块群裂解到拼合的整个过程,孔令耀等(2014)认为这是受控于特提斯洋的演化而逐步形成的一个复杂的造山带.泥盆纪和石炭纪是裂谷作用萌生阶段(赵政璋等,2001),此时青海南部属扬子板块或华夏陆块群的西部边缘,古生物地理区系与华南地区属于暖水的华夏－特提斯区,此时期古纬度约为北纬 14°左右(程鑫等,2011),青藏高原在早二叠世(乌拉尔世)进入“泛裂谷化”的鼎盛期(赵政璋等,2001),自石炭纪开始出现的裂谷此时多数

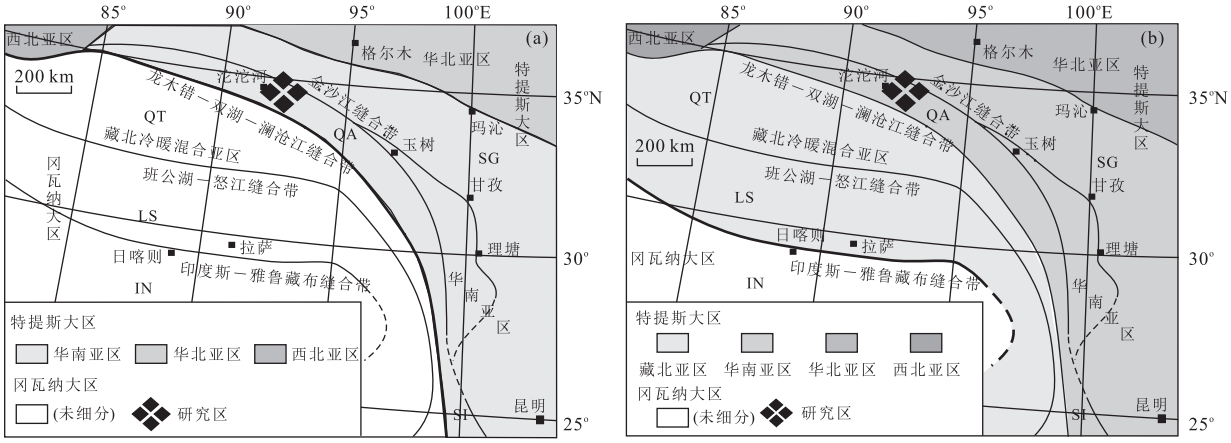

图 6 青藏高原二叠纪生物古地理分区

Fig.6 Permian biogeographic provinces of fusulinids in Tibet and Qinghai plateau

a.早二叠世;b.中－晚二叠世;IN.印度地块;LS.拉萨地块;QA.昌都地块;QT.羌塘地块;SG.松潘－甘孜增生楔杂岩;SI.思茅地块;据 Metcalfe(2002)

或接近陆间裂谷的程度,此时期纺锤类生物群在澜沧江结合带两侧的明显差异性显示出古特提斯洋(澜沧江洋)规模较大,泛华夏大陆南侧与冈瓦纳大陆北侧之间为广阔的古特提斯大洋(罗亮等,2014).中二叠世以 *Neoschwagerina* 为代表的暖水生物群扩展至藏南地区,表明新特提斯洋的打开使得羌塘地块、拉萨地块等裂离冈瓦纳大陆向北迁移至低纬度地区,而新特提斯洋的全面打开促使昌都地块两侧缝合带的闭合,仅局部地区沉积晚二叠世具暖水生物群浅海相乌丽群,而此时期拉萨地块已基本脱离位于冈瓦纳大陆北缘的喜马拉雅带(张以春和沈树忠,2007).

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