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额尔齐斯—西拉木伦对接带古生代沉积盆地演化

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摘要:额尔齐斯—西拉木伦对接带位于西伯利亚板块、华北陆块和准噶尔地块之间,其构造演化和古亚洲洋洋盆的打开与关闭有密切的关系.笔者在系统分析研究区3个二级和19个三级构造单元古生代岩石地层、生物地层及年代地层的基础上,对沉积盆地进行原型恢复,共划分出10个盆地类型.同时,根据沉积盆地充填序列对研究区的构造—沉积演化做出了初步的论述.(1)早古生代—早石炭世古亚洲洋俯冲阶段;(2)早、晚石炭世之交的碰撞演化阶段;(3)晚石炭世—早二叠世碰撞及碰撞后演化阶段.研究认为古亚洲洋的闭合由西向东呈"剪刀式",时间分别为早石炭世末(318 Ma)和中二叠世—早三叠世(260~245 Ma).三叠纪古亚洲洋消亡总体转为陆相环境.

关键词:沉积;构造;盆地演化;古生代;额尔齐斯—西拉木伦.
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Paleozoic Sedimentary Basins Evolution of Ertix-Xar Moron Suture

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Abstract: The Ertix-Xar Moron suture is located at the joint part of Siberia, North China and Junggar, and its tectonic evolution has a close relationship with the opening and closing of Paleo-Asian Ocean basin.In this paper, plates the sedimentary basin types are reconstruted and define 10 basin types by an integrated research on the Paleozoic lithostratigraphy, biostratigraphy and chronostratigraphy are defined. The structure-sedimentary evolution of the study area is discussed based on the sedimentary basin-fill sequence and concluded as the following stages: (1) Early Paleozoic-Early Carboniferous subduction stage of the Paleo-Asian Ocean; (2) Early, Late Carboniferous collisional stage; (3) Late Carboniferous-Early Permian collision and post-collisional evolution stage. It is suggested that the Paleo-Asian Ocean closed from west to east like "scissors", and the closing began from the end of the Early Carboniferous (318 Ma) to the Middle Permian-Early Triassic (260—245 Ma).During Triassic, the Paleo-Asian Ocean disappeared and converted to total terrestrial environment.

Key words: sedimentology; tectonics; basin evolution; Paleozoic; Ertix-Xar Moron.

额尔齐斯—西拉木伦对接带大地构造位于西伯利亚板块和准噶尔构造带及华北板块的转换部位,与古亚洲洋的演化密切相关(Tang,1990;Sengor *et al*.,1993),是解决古亚洲洋形成演化等国际前沿科学问题的关键地区.古生代期间特别是晚古生代期间经历了复杂的洋陆转换过程,残留了系列近东西向及北东向蛇绿构造混杂岩系以及古大陆边缘的增生体系,造就了研究区复杂的岩石地层系统.

关于额尔齐斯—西拉木伦对接带古生代以来的构造演化迄今未形成共识,尤其对其中的蛇绿岩时代、构造属性与就位环境等方面存在争议(李锦轶等,1990;李锦轶,1991,1995;肖序常和汤耀庆,

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1991;刘伟和张湘炳,1993;黄萱等,1997;Hu *et al*.,2000).华北板块与西伯利亚板块之间最终缝合带的位置和碰撞时间也是研究区存在的一个重要问题.Wang and Liu(1986)将西拉木伦河断裂带作为两大板块的缝合带,将林西组及其附近的蛇绿岩作为板块拼合的典型标志;部分学者认为内蒙古北部锡林浩特(贺根山)－苏尼特左旗－索伦敖包一带是华北板块北缘和西伯利亚板块南缘最终缝合带(邵济安,1986;唐克东和张允平,1991;Xu *et al*.,1996;郝旭和徐备,1997),而 Zhang *et al*.(1984)认为缝合带位于贺根山－黑河断裂带.同样古亚洲洋在研究区最终缝合的时间也存在中泥盆世(Tang,1990;徐备和陈斌,1997)、晚泥盆世－早石炭世(邵济安,1991;洪大卫等,1994)、二叠纪(Windley *et al*.,2007)、晚二叠世(Hsü *et al*.,1991)、二叠纪－三叠纪(Li,2006;李锦轶等,2007;Jian *et al*.,2008,2010;Miao *et al*.,2008;Xiao *et al*.,2009)等截然不同的观点.

本文的主要目的是在板块构造理论的指导下,以大地构造控制盆地类型,盆地类型控制岩石建造类型为原则,综合区域地质研究成果(吉林省区域地层表编写组,1978;辽宁省区域地层表编写组,1978;内蒙古自治区区域地层表编写组,1978;新疆维吾尔自治区区域地层表编写组,1981;中国科学院南京地质古生物研究所,1982;吉林省地质矿产局,1988;内蒙古自治区地质矿产局,1991;黑龙江省地质矿产局,1993),通过对额尔齐斯－西拉木伦地区古生代岩石地层、生物地层与年代地层的划分对比,初步建立古生代以来研究区的地层格架和主要门类生物地层(化石带、组合)对比(图 1a,1b),在该格架内,对研究区盆地原型恢复及构造演化进行了初步论述.

1 额尔齐斯－西拉木伦地区古生代沉积盆地划分及其时空分布

在中国各省(市、自治区)1∶25 万建造构造图和 1∶50 万大地构造相图的基础上,对中国大地构造单元进行了系统区划(潘桂棠等,中国大地构造图说明书(1∶250 万),2013).本文采用潘桂棠等的划分方案,将额尔齐斯－西拉木伦对接带划分为 3 个二级和 19 个三级构造单元(图 2;潘桂棠等,中国大地构造图说明书(1∶250 万),2013),图 2 中所划分的二级、三级构造单元分别与本文中的“地层区”和“地层分区”对应.下文按地层区和分区叙述沉积盆地类型与演化历程.

1.1 额尔齐斯地层区

包括额尔齐斯、布尔津、乔夏哈拉－布尔根、北准噶尔－萨吾尔、塔尔巴哈台－洪古勒楞和阿尔曼太－扎河偃 6 个地层分区,生物地层对比、古生代岩石地层及沉积盆地类型划分详见图 1a、图 1b、图 3 和图 4.

早古生代阿尔曼太洋盆向准噶尔地块俯冲,在北准噶尔－萨吾尔、塔尔巴哈台－洪古勒楞及阿尔曼太－扎河偃地区零星出露早古生代地层,自下而上依次为加波萨尔组($O_{2\text{-}3}j$)、大柳沟组(O_3d)、庙尔沟组(O_3m)、沙尔布尔组(S_2s)和克克维库都克组($S_{3\text{-}4}k$).加波萨尔组($O_{2\text{-}3}j$)为滨海－浅海相陆源碎屑－海底火山喷发－碳酸岩建造(柴凤梅等,2012),产珊瑚 *Plasmoporella*、*Agetolites*、腕足类 *Triplesia*,大柳沟组(O_3d)下部以中酸性火山岩为主,局部夹玄武岩和放射虫硅质岩;上部以中基性火山岩为主,夹酸性火山岩和放射虫硅质岩,表明在奥陶纪存在深水环境(田纹全等,2005).庙尔沟组(O_3m)主要为一套火山碎屑－沉积岩夹基性火山岩和灰岩条带,沉凝灰岩中发现大量腕足动物和三叶虫化石,鉴定有 *Odontochile* sp.、*Leptelloidea*、*Encrinuridae*、*Asaphidae*、*Dalmanellidae*、*Strophomenidae*,指示地层时代为晚奥陶世(杨怀龙,2013).沙尔布尔组(S_2s)为浅海相火山碎屑沉积岩、安山岩夹磁铁矿薄层及灰岩透镜体,部分地段具浊流沉积和滑塌堆积,富含浅海生物:珊瑚 *Squameofavosites immensus*、*Favosites gothlandicus*、*F. squamatus*、*Subalveolites porosus* 等和腕足类 *Eospirifertuvaensis* 等.克克维库都克组($S_{3\text{-}4}k$)为一套火山碎屑浊积岩,本组生物化石稀少,主要为一些动物化石碎片.通过对沉积建造和生物组合的系统分析,可知本区在早古生代为弧前盆地环境.

在阿尔曼太山早古生代蛇绿岩中,刘伟和张湘炳(1993)获得蛇纹石化橄榄岩和斜辉橄榄岩 Sm-Nd 年龄 479±27 Ma;黄萱等(1997)则报道了堆晶辉长岩、辉绿岩与安山纷岩 Sm-Nd 全岩等时线年龄 561±41 Ma;肖文交等(2006)在兔子泉一带蛇绿岩中斜长花岗岩中获得 SHRIMP U-Pb 年龄 503±7 Ma;何国琦在阿尔曼太带的硅质岩岩块中发现过 O-S 的放射虫(何国琦,额尔齐斯构造带构造演化与成矿系列研究,1990).在扎河坝地区,金成伟等(2001)获得堆晶橄榄岩的全岩等时线年龄 478.9 Ma;何国琦等(2001)获得辉长岩中斜长石的

地层层序			主要门类化石分带、组合					
统	组	笔石	筵类	珊瑚	腕足类	双壳－叶肢介－菊石	植物	三叶虫
上二叠统	扎河坝组						*Callipteris-Noeggerathiopsis Comia Compsopteris Schizoneura*	
中二叠统	库尔提组		*Neomisellina Neoschwagerina craticulifera Chusenella conicocylindrica Pseudodoliolina*	*Waagenophyllum Wentzelella Metriophyllum*	*Transennatia Rugivestia Waagenites grandicasta Urushtenia Megaderbyia Echinauris jisuensis*	*Strigogoniatites Dubichites Metalegoceras Tauroceras Waagenoceras* (菊)	*Sphenopteris incrassatia Noeggerathiopsis latitalia Zamiopteris lanceolata*	
下二叠统	卡拉岗组		*Monodiexodina Parafusulina Misellina ovalis Paratusulina sanmianjingensis Schubertella*	*Yatsengia Polythecalis Lytvolasma Allotropiophyllum*	*Pacamarginifera zesiensis Yakovlevia unsinuata Orthotichia morganiana Reticulatia huecoensis*	*Paragastrioceras Uraloceras Propinacoceras Neocrimites*	*Angaropteridium-Zamiopteris Cordioneura Noeggerathiopsis*	
	哈尔加乌组							
上石炭统	巴塔玛依内山组		*Profusullinella Pseudostaffella*	*Cystodendropora-Caninophyllum-Pseudotimania-Syringaxoinoides*	*Choristites mosquensis-Dictyoclostus houyuensis*		*Cardioneura-Angaropteridium Neuropteris-Angaridium*	
下石炭统	那林卡拉组			*Caninia dorlodofi Carinthiophyllum-Lophophyllum*	*Dictyoclostus houyuensis*	*Beyrichoceras-Michelinoceras Prolecanites* cf. *Serpentinus* (菊)		
	姜巴斯套组			*Siphonophyllia-Palaeosmilia-Gangamophyllum*	*Syringothyris altaica-Fluctuaria camriniformis-Pustula*		*Tomiodendron-Caenodendron Lepidodendropsis-Mesocalamites*	
	黑山头组			*Neozaphrentis xinjiangense-Meniscophyllum irregulare*	*Syringothyris hannibalensis-Spirifer subgrandis*			
上泥盆统	卡西翁组			*Pachyfavosites*	*Tenticospirifer Cyrtiopsis sinensis Storpheodonta Camarotoechia*		*Lept. Rhombicum-Cyclostigma kiltorkense*	
中泥盆统	巴尔雷克组			*Thamnophyllum-Keriophyllum*	*Schizophoria-Euryspirifer-Emanuella*		*Protolepidodendron scharyanum-Barrandeina dusliana*	
	库鲁木迪组			*Pachyfavosites polymorphus-Tyrganolite xinjianggolites*	*Atrypa desquamata-Chonetes kwangsiensis-Leptostrophia*			
下泥盆统	卓木巴斯套组			*Syringaxon-Orthopaterophyllum shapburense Aulocysis-Steatothamnopora-Pleurodictyum Squameofavosites-Planocoenites-Pseudofavosites*	*Paraspirifer-Rhytistrophia-Leptaenopyxis*		*Sciadophton pristinum*	
顶志留统	克克维库都克组	*Transgrediens Tumescens Nilssoni Monograptus*		*Kodonophyllum-Chlamydophyllum Thecia-Mesofavosites-Cladopora*	*Plectatrypa Chonetes Camarotoechia*	*Ptychopteria*(双壳)	*Zosterophyllum*	*Encrinurus*
上志留统								
中志留统	沙尔布尔组	*Lundgreni Ramosus Flexilis Rigidus Riccartonensis Murchisoni Centrifugus Insectus*		*Crassilasma-Yassia Multisolenia-Subalveolites-Halysites Ningqiangolites-Visbylites-Propora*	*Pentamerus-Eospirifer Crassilasma-Yassia*	*Madiomorpha hoboksarensis*(双壳) *Leiopecten hoboksarensis*(双壳)		*Encrinurus Calymene Cheiruriadae*
下志留统								
上奥陶统	庙尔沟组				*Leptellina maxima*			*Encrinurus Asaphidae*
	大柳沟组				*Strophonella Isorthis*			
中奥陶统	加波萨尔组			*Plasmoporella-Agetolites Rhabdotetradium-Catenipora-Eofletcheria*	*Pseudolingula-Triplesia*			*Remopleurides*
下奥陶统								

图 1a　额尔齐斯地区古生代生物地层划分对比

Fig.1a　Fossil zones and assemblages of Paleozoic strata in Ertix area

地层层序		主要门类化石分带、组合				
统	组	筵类	珊瑚	腕足类	双壳－叶肢介－菊石	植物
上二叠统	林西组				*Huanghestheria-Pemphicylus*(叶) *Palaeonodonta-Palaeomutella*(双)	*Callipteris-Noeggerathiopsis*(安加拉) *Neuropterodium-Lobatannularia*(混生)-*Comia*
中二叠统	哲斯组	*Codonofusiella-Pseudodoliolina* *Neoschwagerina*	*Waagenophyllum-Wenizelella*	*Spiriferella-Kochiproductus-Yakovlevia*	*Rhiphaeoceras zhesiense*(菊)	*Sphenophyllum* *Gigantonoclea* *Pecopteris* *Taeniopteris* *Calamites*(华夏)
	包格特组	*Monodiexodina-Parafusulina*	*Allotropiophyllum-Tachylasma*	*Anidanthus-Muriwoodia*		
	大石寨组	*Misellina*	*Szechuanophyllum*		*Popanoceras*(菊)	
下二叠统	阿木山组	*Eoparafusulina* *Pseudoschwagerina* *Pseudofusulina fecunda* *Triticites*	*Empodesma-Tachylasma* *Carinthiophyllum-Akagophyllum* *Hillia-Antheria*	*Choristites* cf. *jigulensis* *Hustedia* sp. *Stenoscisma* sp. *Ella* sp.		*Angaropteridium-Angaridium potaninii-Neuropteris plicata*(安加拉) *Neuropteris pseudovata-Lepidodendron tachingshanense*(华夏)
上石炭统	本巴图组	*Fusullina-Fusullinella* *Profusullinella* *Pseudostaffella*	*Amplexus abnormis-Bradyphyllum bellicastatum*	*Choristites mosquensis-Dictyoclostus houyuensis*		*Angaropteridium-Noeggerathiopsis*(安加拉) *Neuropteris gigantea-Linopteris brongniarti*(华夏)
下石炭统	磨盘山组	*Eostaffella*	*Yuanophyllum-Hexaphylla*	*Gigantoproductus edelburgensis-G.manchouriensis*	*Epicanite-Sudeticeras*(菊)	*Angaridium panshiense*(安加拉)
	色日巴彦敖包组			*Fusella-Syringothyris Rugauria-Sphenospira*		

地层层序		主要门类化石分带、组合									
统	组	笔石	珊瑚	腕足类	三叶虫	牙形刺	竹节石	介形类	海参骨片	腹足类	苔藓虫	层孔虫
上泥盆统												
中泥盆统	王家街组		*Pachyfavosites-Favosites*			*S.eosteinhornensis*, *Panderodus gracilis* *Spathognathodus steinhornensis*	*Uniconus* sp., *Gotlandellites* ? sp. *Tentaculites* sp., *Vjalovites* ? sp.,	*Acanthoscaphaaris*	*Eocaudina septaforaminalis*	*Enomphalus Oriostoma*	*Fenestella Semicoscinium-Phaenopora*	*Amphipora angasta*,*Stachyodes*
下泥盆统												
顶志留统	西别河组		*Carlinastraea sugiyamai* *Mucophyllum infundibula-Entelophyllum jilinense* *Spongophyllum younjiense-Microplasma xiaosuihensi*	*Coelospira-Nucleospira* *Idioglyptus-Isorthis*	*Calymene* *Encrinurus*							
上志留统			*Entelophyllum* aff. *Vassense-Schlotheimophyllum*	*Protoreticularia* *Hedeina*	*Cyphoproetus* *Hypaproelus* *Phacops*							
中志留统	徐尼乌苏组		*Halysites-Mucophyllum*									
下志留统	桃山组	*Streptograptus runcinatus-Rastrites* cf. *linnaei* *Spirograptus turriculatus* *Streptograptus exiguus-S.*cf. *cripus* *Oktavites spiralis* *Monoclimacis* cf. *Griestoniensis-M.vomerinus* *Retiolites geinitziamus-Stomatograptus* cf. *grandis*										
上奥陶统												
中奥陶统	哈拉组	*Dicellograptus sextans-Climacograptus putillus* *Phyllograptus anna*		*Dolerorthis-Platystrophia* *Diparelasma dongbeiensis* *Famatinorthis luoheensi-Brandysia biconvexa*	*Ampyx*延伸带							
下奥陶统	乌宾敖包组			*Productorthis americana* *Hesperonomia-Cyrtonotella*	*Cybelurus-Asaphus*							

图 1b 西拉木伦地区古生代生物地层划分对比

Fig.1b Fossil zones and assemblages of Paleozoic strata in Xar Moron area

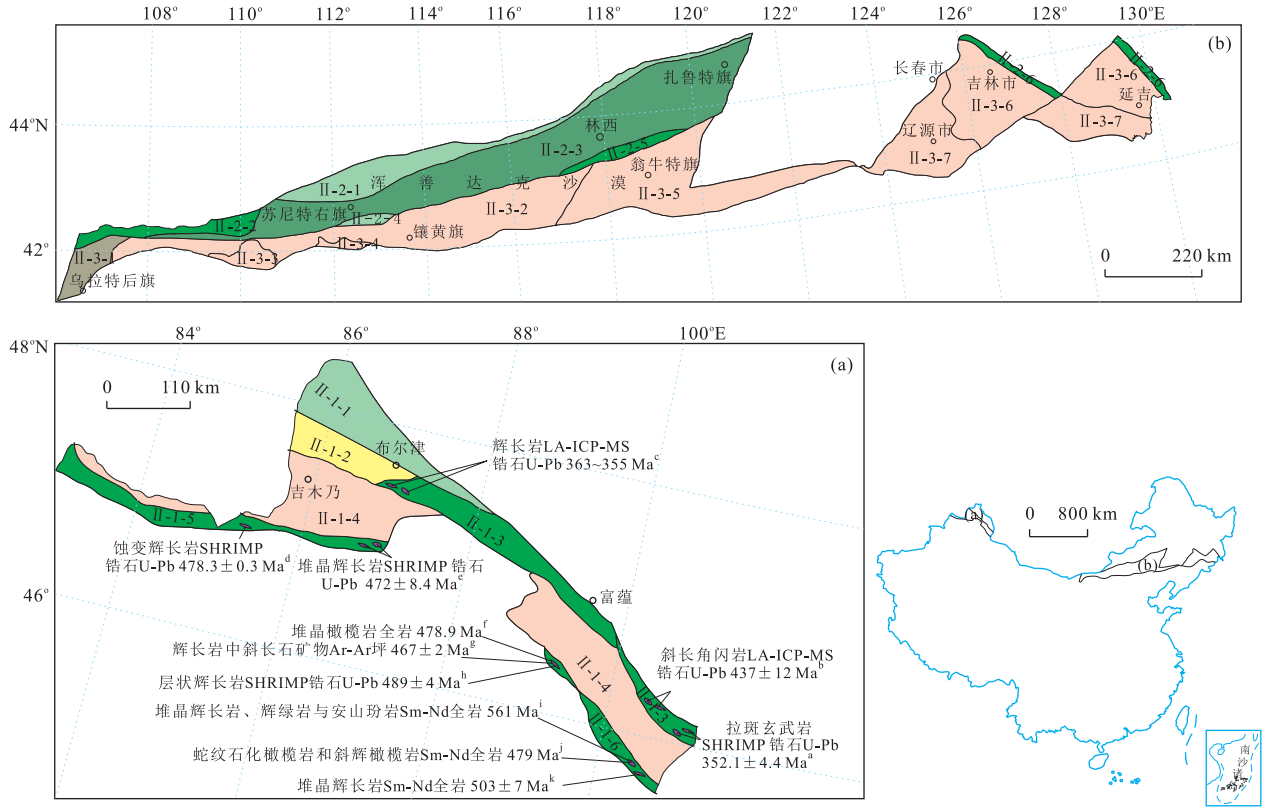


图 2　额尔齐斯—西拉木伦大地构造格局与构造单元划分

Fig.2　Sketch map of Ertix-Xar Moron tectonic framework and tectonic units

Ⅱ-1.额尔齐斯结合带:Ⅱ-1-1.额尔齐斯复合增生楔(D-C),Ⅱ-1-2.陆内断陷盆地(N-Q),Ⅱ-1-3.乔夏哈拉—布尔根蛇绿混杂岩(D_1-C_1),Ⅱ-1-4.北准噶尔—萨吾尔洋内弧(D_1-C_1),Ⅱ-1-5.塔尔巴哈台—洪古勒楞蛇绿混杂岩(D_1-C_1),Ⅱ-1-6.阿尔曼太—扎河堰蛇绿混杂岩(D_1-C_1);Ⅱ-2.索伦山—西拉木伦结合带:Ⅱ-2-1.白音宝力道(查干乌拉)俯冲增生杂岩(O-D),高压蓝片岩变质杂岩,Ⅱ-2-2.索伦山蛇绿混杂带(D-P_1),Ⅱ-2-3.林西残余盆地(P_2-T_1),Ⅱ-2-4.温都尔庙俯冲增生杂岩(O),高压蓝片岩带,Ⅱ-2-5.柯单山—小苇塘蛇绿混杂岩带(C-P),Ⅱ-2-6.机房沟—汪清—珲春蛇绿混杂岩带(C-P);Ⅱ—3.包尔汗图—白乃庙弧盆系:Ⅱ-3-1.宝音图基底残块(Pt_1),岩浆弧(Pz_2),Ⅱ-3-2.镶黄旗—多伦陆缘岩浆弧(Pz_2),断陷—火山沉积盆地(K_1),Ⅱ-3-3.包尔汗图岛弧(Pz_1),Ⅱ-3-4.白乃庙岛弧(Pz_1),Ⅱ-3-5.通辽岩浆弧(SD_1,Pz),Ⅱ-3-6.盘石—百里坪岩浆弧(Pz),Ⅱ-3-7.下二台—呼兰岩浆弧(Pz);a.吴波等(2006);b.张越等(2012);c.王玉往等(2011);d.朱永峰和徐新(2006);e.张元元等(2010);f.金成伟等(2001);g.何国琦等(2001);h.简平等(2003);i.黄萱等(1997);j.刘伟和张湘炳(1993);k.肖文交等(2006);据潘桂棠等,中国大地构造图说明书(1∶250 万),2013 修改

Ar-Ar 坪年龄为 467±2 Ma;简平等(2003)报道蛇绿岩中层状辉长岩的 SHRIMP 年龄为 489±4 Ma.朱永峰和徐新(2006)获得塔尔巴哈台库吉拜蛇绿岩中蚀变辉长岩 SHRIMP U-Pb 年龄为 478.3±3.3 Ma;张元元等(2010)在洪古勒楞蛇绿岩中获得堆晶辉长岩的 SHRIMP U-Pb 年龄为 472±8.4 Ma.从蛇绿岩形成的年代学资料可以看出,塔尔巴哈台—洪古勒楞、阿尔曼太—扎河坝蛇绿混杂岩在晚寒武世—早奥陶世已经形成,表明在早古生代早期古亚洲洋发生洋内俯冲作用.张越等(2012)在新疆富蕴县西部玛因鄂博蛇绿岩中斜长角闪岩中获得 U-Th-Pb 年龄 437±12 Ma,为早志留世,地球化学特征显示为典型的大洋拉斑玄武岩(N-MORB 型),可能代表了该区消失了的古洋壳残片.

泥盆纪—早石炭世,洋盆继续俯冲消减,在乔夏哈拉—布尔根地区沉积了巨厚的火山沉积岩系,岩石地层序列由老至新依次为康布铁堡组(D_1k)、姜巴斯套组(C_1j).康布铁堡组(D_1k)主要由变质中酸性火山岩、火山碎屑岩、碎屑岩夹碳酸盐岩等组成,刘伟等(2010)获得流纹岩和花岗闪长岩锆石 U-Pb 年龄 401 Ma,表明其火山活动的时代在早泥盆世.姜巴斯套组(C_1j)为富含钙质的火山碎屑岩和陆源碎屑岩,岩石类型包括玄武岩—酸性火山碎屑岩—玄武粗面安山岩;汪帮耀等(2011)得到玄武粗面安山岩锆石 U-Pb 年龄 319.8±2 Ma,表明姜巴斯套组火山岩形成于早石炭世.吴波等(2006)在布尔根蛇绿混杂岩中获得拉斑玄武岩 SHRIMP 锆石年龄 352 Ma,说明蛇绿岩的形成于晚泥盆世—早石炭

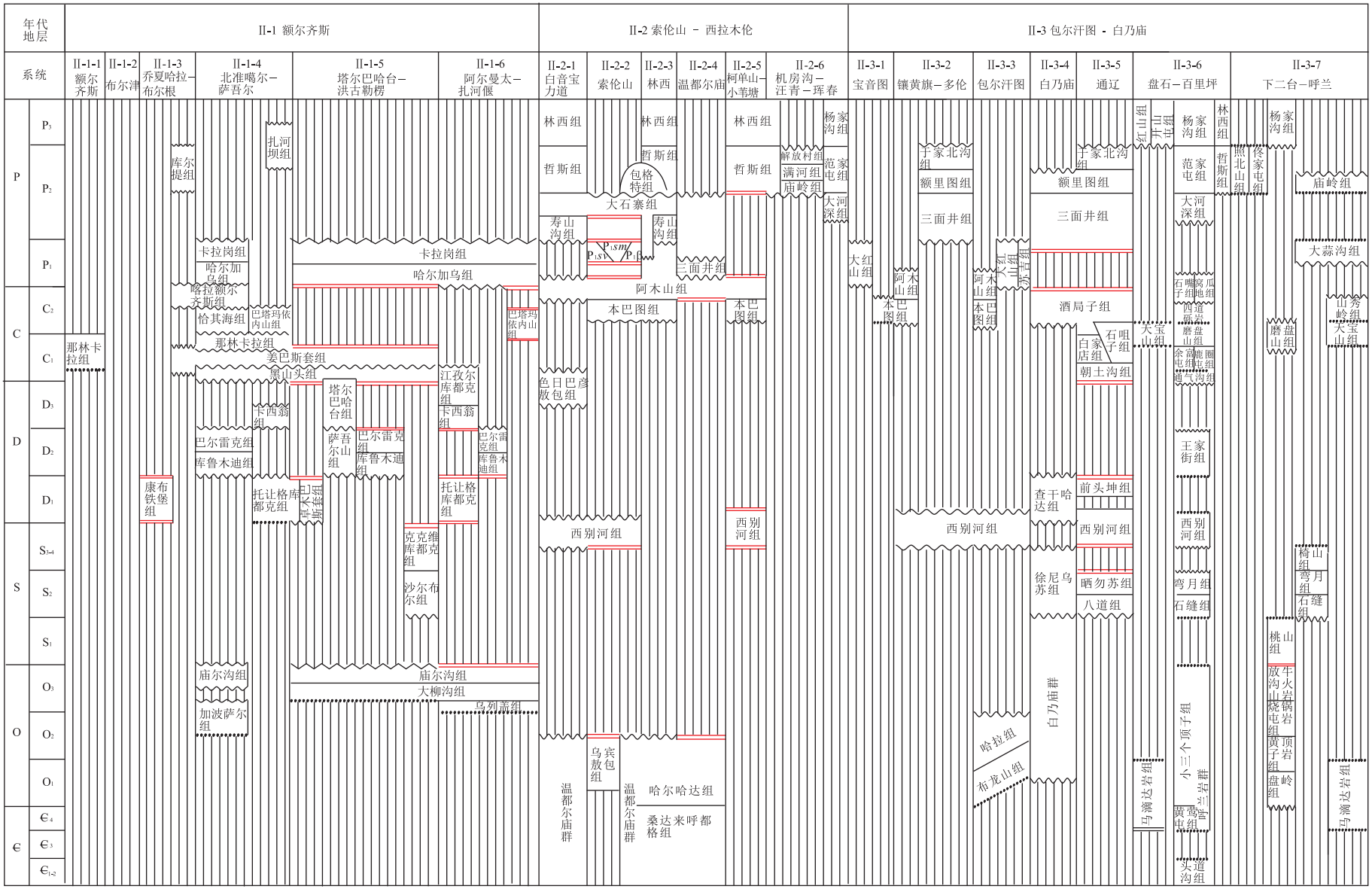


图3 研究区古生代岩石地层单位序列

Fig.3 Lithostragraphic sequence of Paleozoic strata in study area

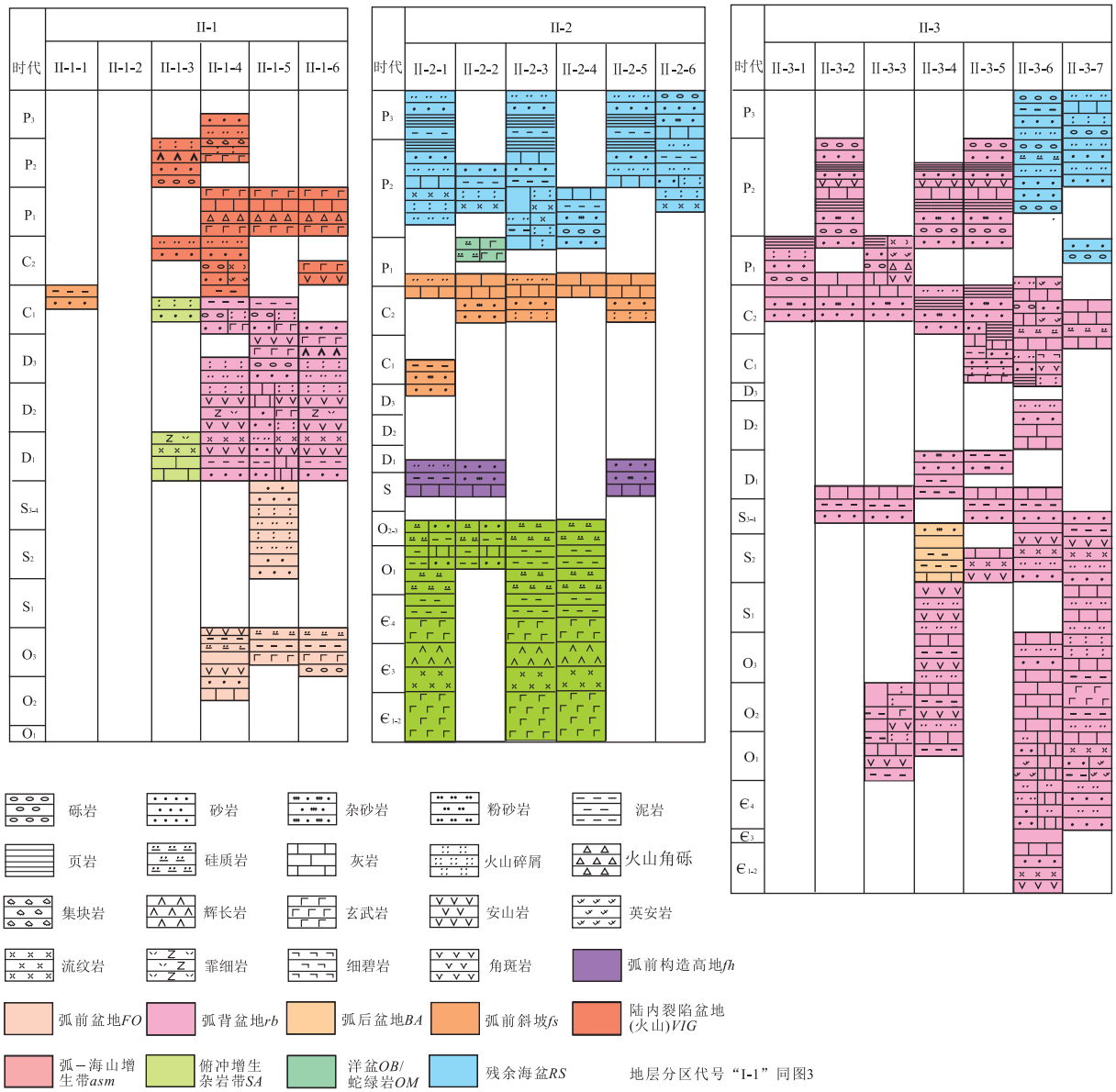


图 4　研究区古生代沉积盆地划分

Fig.4　Paleozoic sedimentary basin classification of study area

世,同时发现乔夏哈拉和布尔根混杂岩带中存在多种性质和环境来源的岩块.王玉往等(2011)对位于布尔津南部的吐尔库班套蛇绿混杂岩中的辉长岩和片麻状花岗岩分析,得到锆石 U-Pb 年龄 363～355 Ma,指示蛇绿岩的形成、洋壳俯冲时代在晚泥盆世晚期.根据上述分析,可知乔夏哈拉—布尔根地区在泥盆纪—早石炭世盆地类型为俯冲增生杂带.额尔齐斯地区为那林卡拉组(C_1n)海陆交互相建造沉积,下部滨海相碎屑岩夹少量的流纹岩和玄武岩,产菊石 *Beyrichoceras* sp.、*Michelinoceras* sp.、*Prolecanites* cf.*serpentinus*、珊瑚 *Caninia* sp.、*Cryptophyllum* cf.*hibernicum*、*Zaphrentites* sp.、*Lophophyllum* sp.、*Carcinophyllum* sp.、腕足类 *Dictyoclostus* sp.;其上部为陆相含煤地层,含安加拉植物(孙成旺等,2011).富含火山岩夹层的海陆交互相碎屑沉积,说明那林卡拉组是在弧前斜坡环境下形成的.

北准噶尔—萨吾尔、塔尔巴哈台—洪古勒楞和阿尔曼太—扎河偃地区在泥盆纪主要沉积了一套具有双峰式特征的浅海相—陆相火山沉积岩系(李锦轶,2004).托让格库都克组(D_1t)为以玄武岩、安山玄武岩为主的双峰式火山岩夹凝灰砂岩及少量碳酸盐岩,并发育有代表大洋板块俯冲作用的早期产物——埃达克岩和富铌玄武岩,表明古亚洲洋板块

在早泥盆世就已开始俯冲(张海祥等,2004;Zhang *et al*.,2005).卓木巴斯套组(D_1z)为一套浅海－滨海相富含钙质的碎屑岩及碳酸盐岩沉积,含丰富的腕足和珊瑚化石.库鲁木迪组(D_2k)为一套浅海相－滨浅海相火山碎屑岩和碎屑岩组合,含珊瑚 *Barrandeophyllum* cf. *bohemicum*、*Calceola* sp.、*Pachyfavosites* sp.、三叶虫 *Phacops* cf. *latiformis*、腕足 *Atrypa desquamata*、*Leptostrophia* cf. *heitaiensis*.时代为中泥盆世早期(王海博,2011).巴尔雷克组(D_2b)为一套次深海相陆源碎屑类复理石沉积,含 *Thamnopora halenae*、*Threticulata*、*Pachyfavosites* cf. *macrofremata* 等中泥盆世上部分子(林宝玉,1984;王海博,2011).萨吾尔山组(D_2s)下部为海相至海陆过渡相陆源细碎屑岩夹安山岩、灰岩;上部为海相中性－中酸性火山碎屑岩,该组地层中化石丰富,其中珊瑚化石 *Thamnopora pansienesis*、*Temnophyllum*、*Hexagonaria* 和植物化石 *Psilophytites*、*Psilophyton bellum* 为中泥盆世的标准化石(谭绿贵,2006).翁凯等(2013)获得萨吾尔山组内安山岩锆石 U-Pb 年龄 391±3 Ma.卡西翁组(D_3k)主要为滨－浅海相夹陆相火山碎屑－碎屑沉积岩,局部见玄武岩和流纹岩,含丰富的植物 *Leptophloeum rhombicum*、*Lepidosigillaria acuminata*、*Aphyllopteris tenuis*、腕足 *Tenticospirifer* sp.、*Cyrtospirifer* sp.、*Camarotoechia* sp.、珊瑚 *Pachyfavosites* sp.、*Syringaxon* ? sp.,时代为晚泥盆世(柴凤梅等,2012).塔尔巴哈台组(D_3t)属浅海环境及滨海环境沉积,该组含晚泥盆世标准种植物化石 *Leptophloeum rhombicum*,故确定其时代为晚泥盆世(新疆维吾尔自治区地质局,中华人民共和国区域地质调查报告－塔城幅－阿西勒幅(1∶20万),1985).王宇等(2009)在塔尔巴哈台组发现植物化石,经鉴定为石松类亚鳞木 *Subleridodendron*,其时代为晚泥盆世.江孜尔库都克组(D_3C_1j)为火山碎屑岩夹中基性和中酸性火山岩组合.早石炭世地层为黑山头组(C_1hs)和姜巴斯套组(C_1j).黑山头组(C_1hs)整体为一套火山岩、含火山灰碎屑岩和碎屑岩组合,锆石 U-Pb 年龄 349±8 Ma,时代为早石炭世(田陟贤等,2013).根据富含火山岩夹层的海陆交互到浅海相碎屑沉积或不连续的海相碳酸盐岩沉积,说明该地区在泥盆纪－早石炭世进入弧背盆地(岩浆弧)沉积阶段.

晚石炭世－二叠纪,本区仍以火山碎屑岩－陆源碎屑岩沉积为主,但火山岩的性质呈现出较大反差,由基性－酸性火山熔岩转变为典型的碱性火山岩.表明早晚石炭世之交俯冲作用结束并发生碰撞,洋盆最后闭合.在乔夏哈拉－布尔根地区依次沉积喀喇额尔齐斯群(C_2k)和库尔提组(P_2k).喀喇额尔齐斯群(C_2k)主要为凝灰岩、绢云母板岩、硅质岩、长英质角岩、石榴石长英角岩,含孢粉 *Punctatisporites* sp.、*Granulatisporites* sp.、*Calamospora* sp.、*Retusotriletes* sp.、*Lueckisporites* sp.及植物 *Calamites* sp.(马俊强等,2012).库尔提组(P_2k)上部为黄褐色火山砾岩;下部为灰色巨砾岩,属主碰撞期后的后碰撞伸展阶段的产物,表明盆地类型转变为陆内裂陷盆地.

北准噶尔－萨吾尔、塔尔巴哈台－洪古勒楞和阿尔曼太－扎河偃地区依次沉积巴塔玛依内山组(C_2b)、恰其海组(C_2q)、哈尔加乌组(P_1h)、卡拉岗组(P_1k)和扎河坝组($P_{2\text{-}3}z$).巴塔玛依内山组(C_2b)下部为橄榄玄武岩夹少量凝灰角砾岩;上部为酸性流纹斑岩、英安斑岩,夹少量中性安山岩及酸性火山碎屑岩,为陆壳裂谷双峰式火山喷发类型,在火山碎屑沉积岩中产较丰富的安哥拉植物群 *Angaropteridium* cf. *cordiopteroides*、*Noggerothiopsis* sp.、*N*. cf. *theodori tschirkovaet*、*N*. *subangusta*、*Calamites* sp.等,植物化石组合表明巴塔玛依内山组陆相火山－沉积体系形成于晚石炭世早期(朱志新等,2005).其中火山岩为碱性系列,指示了其形成于大陆板内环境下(张招崇等,2007).哈尔加乌组(P_1h)上部为安山玢岩、块状中性凝灰岩、火山角砾岩、霏细斑岩质火山角砾岩和流纹岩;下部为凝灰砾岩、凝灰岩、凝灰质砂岩和火山角砾岩,产 *Angaropteridium-Zamiopteris* 植物组合.卡拉岗组(P_1k)以中酸性火山岩为主,夹少量的火山碎屑岩,岩石组合特征表明其形成于陆内造山阶段的大陆拉张构造环境,与火山岩的地球化学特征研究结果一致(木合塔尔·扎日等,2002),同时含大量 *Angaropteridium-Zamiopteris* 植物组合,并混入华夏－欧美区系重要分子 *Taeniopteris* sp.、*Sphenophyllum thonii* 及 *Sphenobaiera* ? *spirata* 等,其时代为早二叠世晚期(木合塔尔·扎日,1994;新疆地质矿产局,1999).扎河坝组($P_{2\text{-}3}z$)为板内玄武岩－安山岩－英安岩夹凝灰岩和粉砂岩,产植物 *Callipterisaltaica*、*Zamiopteris glossopteroides*、*Noeggerathiopsis iljinskiensis*、*Pursongia*、*Carssinervia* 和 *Iniopteris*.梅厚钧等(1993)研究表明早二叠世扎河坝组火山岩的构造背景为大陆板内环境,说明本区在晚石炭世－二

叠纪已完全进入陆内演化阶段.

1.2　索伦山—西拉木伦地层区

包括白音宝力道、索伦山、林西、温都尔庙、柯单山—小苇塘和机房沟—汪青—珲春 6 个地层分区.古生代岩石地层、生物地层对比及沉积盆地类型划分详见图 1b,图 3,图 4.

寒武纪—志留纪,在本区形成温都尔庙群(Pz_1wd),下部桑达来呼都格组、上部哈尔哈达组.桑达来呼都格组是一套原岩以玄武岩为主的绿色片岩组合,局部夹碳酸盐岩透镜体,下部为辉长岩体,未见底,与上覆的哈尔哈达组整合接触.哈尔哈达组为一套绢云(二云、绿帘)石英片岩、含铁石英岩夹大理岩透镜体、绿片岩.可分南带和北带,南带出露在温都尔庙—图林凯一线,北带位于二道井—苏尼特左旗南部—红格尔一线.徐备等(2001)在白音宝力道地区利用 Sm-Nd 全岩等时线法获得混杂岩块中超镁铁质和铁镁质岩块的年龄 409±13 Ma,同时在混杂岩块中发现与高压变质相关的蓝片岩(徐备和陈斌,1997).张覆桥(未发表)在二道井地区温都尔庙群中获得 Rb-Sr 全岩等时线年龄 446 Ma.唐克东和张允平(1991)在白音宝力道地区岛弧闪长岩带中得到英云闪长岩和花岗闪长岩 U-Pb 锆石年龄 452 Ma和 447 Ma.关于南带温都尔庙群的形成时代也一直存在争议,内蒙古自治区地质矿产局(1991)将其定为中元古代;刘敦一等(2003)从图林凯蛇绿岩中的石英闪长岩、英安岩、奥长花岗岩和斜长岩分别获得了锆石 SHRIMPP U-Pb 年龄 467±13、459±8、451±7 和 429±7 Ma;Jian *et al*.(2008)在图林凯南侧获得温都尔庙蛇绿岩锆石 SHRIMP 年龄 497～477 Ma,认为它们属于 SSZ 型蛇绿岩,这些年龄表明蛇绿岩的形成时代可能在寒武纪—奥陶纪.李承东等(2012)对温都尔庙洋内弧变质安山岩及变质碎屑岩进行锆石 U-Pb 同位素测年表明:桑达来呼都格组上部洋内弧变质安山岩年龄为 470±2 Ma,哈尔哈达组碎屑锆石年龄集中在 445～480 Ma范围内,进一步将温都尔庙群的时代限定为寒武纪—中志留世.本文采用李承东等(2012)方案,时代为寒武纪—中志留世.该区在早古生代为含蛇绿岩的俯冲增生杂岩带.

晚志留—早泥盆世,在研究区主要沉积了西别河组(S_4D_1x),由一套滨浅海相陆源碎屑岩、生物碎屑灰岩及生物礁组成,含牙形石 *Panderodus*、*Icriodus angustoides* 等、珊瑚 *Altaja-Weissermelia* 组合带、*Spongophyllum-Ptychophyllum* 组合带、腕足 *Conchidium-Kirkodium* 组合带、*Protathyrisina-Atrypoidea* 组合带,确定该组时代为顶志留世—早泥盆世(苏养正等,1983;张永清等,2004;王平,2006),沉积环境演化为弧前构造高地.

石炭纪—早二叠世早期,在本区依次沉积色日巴彦敖包组(D_3C_1s)、本巴图组(C_2bb)和阿木山组(C_2P_1a).色日巴彦敖包组(D_3C_1s)为一套陆相—海陆交互相浅变质火山—碎屑沉积岩建造,产珊瑚 *Nalivkinella*、*Kueichowpora* 等.依据地层底部灰黑色凝灰质粉砂质硅泥质板岩中发现的早石炭世陆相古植物化石 *Archaeocalamates*(古芦木),确定该套地层形成时代为早石炭世,结合区域地层对比,将其时代置于晚泥盆世—早石炭世(徐备和陈斌,1997;王弢等,2012).本巴图组(C_2bb)在不同地段岩性特征有很大不同,主要为凝灰岩、粉砂岩和含砾屑砂岩夹中薄层结晶灰岩.上部以粉砂岩和杂砂岩为主,夹安山质凝灰岩、安山岩和灰岩透镜体,含籉化石 *Triticites* sp.、*Schuwaqerina* sp.等.中部岩性为安山质晶屑凝灰岩、凝灰质砂岩互层,夹少量砾岩和安山岩.下部以杂砂岩、粉砂岩和杂砂岩为主,夹安山岩、安山质凝灰岩和灰岩透镜体,含籉化石 *Fusulinella* sp.、*Profusulinella* sp.、*Eostaffella* sp.、珊瑚 *Lithostrotionella* sp.、*Amygdalophyllum* sp.、*Koninckophyllum* sp.,时代为晚石炭世.阿木山组(C_2P_1a)底部为钙质胶结的石英砾岩.上部岩性以灰色—青灰色—厚层结晶灰岩为主,反映稳定温暖浅海环境;下部由浅变质的碎屑岩构成.在灰岩中发现的籉类化石,主要有 *Parafusulina lungtanensis*、*P. gracilis*、*S.vulgaris*、*S.richthofeni*,时代应为晚石炭世晚期,为弧前斜坡环境.

早二叠世,索伦山地区沉积了硅质岩岩片(P_1sv)和枕状玄武岩($P_1\beta$)及硅质岩夹凝灰岩、泥岩(P_1sm),进入洋盆演化阶段.中二叠世本区沉积了大石寨组($P_{1\text{-}2}ds$)基性、中基性和酸性熔岩及凝灰岩组合,局部夹碎屑岩,产珊瑚 *Lophoca rinophyllum*、*Lytvolasma* 和 *Tachylasma*(内蒙古自治区地质矿产局,1991).大石寨组火山岩的年龄测试结果多为 286～270 Ma(高德臻和蒋干青,1998;陶继雄等,2003).郭峰等(2009)根据大石寨组玄武岩地球化学特征,认为其为古亚洲洋俯冲板片析出流体交代的熔融产物,说明古亚洲洋的俯冲仍在继续.哲斯组(P_2zs)为一套滨、浅海相碎屑岩和碳酸盐岩夹火山岩.尚庆华(2004)在哲斯地区发现放射虫化石,以球型类型为主,另外含 *Hegleria mammilla*、*Hegleria* sp.、*Entactinosphaera*? sp.、

Staurolonche? sp.以及 *Ishigaum* ? sp.、*Pseudoalbaillella* ? sp.等,说明该地区主体应为深水海相沉积.结合在哲斯组内发现的 *Yakovlevia gigantica*、*Y.elongeta*、*Kochiproductus porrectus*、*Anidanthus rugousa*、*Pseudomarginifera ussuricus*、*Fusispirifer concinnus*、*Alispiriferella sinensis*、*A.neimongolensis*、*Spiriferellamagna*、*S.salteri*、*Blasispirifer rhombicus*、*Spirifera zhesiensis*、*Altiplecus mongolica*、*Spiriferellina cristata* 等腕足动物化石(王成文和张松梅,2003),确定哲斯组属中二叠世沉积.林西组(P_3l)以湖相、泻湖相黑灰色为主色调的砂岩板岩组合,含 *Palaeanodonta* 和 *Palaeomutela* 动物群及植物化石.张永生等(2012)在索伦地区发现 *Huanghestheria*、*Cyclotunguzites*、*Sphaerorthothemos* 等叶肢介化石,为林西组晚二叠世时代的确定提供了可靠的化石证据.和政军等(1997)研究认为,在内蒙古中部地区晚二叠世林西组中—下部以海相沉积为主,并发育浊流沉积,向上变为陆相沉积,反映直到晚二叠世晚期残余海盆才逐渐消失.

1.3 包尔汗图—白乃庙地层区

包括宝音图、镶黄旗—多伦、包尔汗图、白乃庙、通辽、盘石—百里坪和下二台—呼兰 7 个地层分区.生物地层对比、古生代岩石地层及沉积盆地类型划分详见图 1b,图 3,图 4.

寒武纪—早志留世,头道沟组($\in t$)原岩建造为基性—中基性—中性—中酸性沉积碎屑岩—碳酸盐建造.鲁若飞等(2010)认为头道沟组沉积时为海底火山强烈喷发的环境.呼兰群($\in$-OH)是一套中浅变质岩系,包括黄莺屯组和小三个顶子组.黄莺屯组是一套以海相中基性—中酸性的火山喷发为主的沉积建造,反映了碎屑沉积—碳酸盐沉积并伴随火山喷发活动的沉积特点.小三个顶组是一套中酸性火山岩—碎屑岩—碳酸盐沉积.郗爱华等(2003)获得呼兰群地层 Rb-Sr 全岩等时线年龄为 524～357 Ma.包尔汉图群($O_{1\text{-}2}B$)包括布龙山组和哈拉组,布龙山组为一套深海硅泥质沉积;哈拉组为中基性火山岩和火山碎屑岩,产笔石 *Callograptus*、*Desmograptus*、*Dictyonema*、*Aspidograptus*、*Dicranograptus* 等,时代为早—中奥陶世,钙碱性火山岩为岛弧火山作用的产物(师春和师雅洁,2012).张超(2013)得到白乃庙群中黑云母变粒岩的形成年龄为 499.4±1.8 Ma,绿泥绢云母片岩的形成年龄为 478.1±1.6 Ma,代表白乃庙群的形成时代可能为晚寒武世—中奥陶世.谷丛楠(2012)从该群的变质安山岩中获得锆石年龄 450.0±4.0 Ma,为晚奥陶世.童英等(2010)在白乃庙矿区北东侧侵入白乃庙群的石英闪长岩中获得锆石年龄分别为 459±2.9 Ma 和 454±14 Ma.区域上,白乃庙群被中志留世徐尼乌苏组不整合覆盖(胡晓等,1990),限定了该群形成时代的上限,即不会晚于中志留世.根据沉积建造特征,该地区在寒武纪—早志留世进入弧背盆地(岩浆弧)沉积阶段.

中志留世—泥盆纪,徐尼乌苏组($S_{2\text{-}3}x$)为一套浅变质碎屑岩.自下而上被分为 3 个沉积旋回,第 1 个旋回以火山沉积岩系为主;第 2、3 两个旋回均以含砾砂岩开始,中部为长石石英砂岩、石英砂岩,顶部为碳酸盐岩,为水下三角洲和浊流沉积.该组底部的碎屑岩分选差,属于近源快速堆积,具磨拉石建造特征,沉积环境属于弧后盆地.西别河组(S_4D_1x)下部底砾岩层,砾石成分以下伏地层的砾石为主,磨圆度和分选性较差;中部为为杂色碎屑岩夹灰岩;自下而上碎屑颗粒变细,灰岩成分升高;上部为石英砂岩和中厚层灰岩和泥质灰岩,顶部有礁灰岩,可见珊瑚 *Favorites* spp.、*Favorites* cf.*yakowlewi*、*Mesofavosites* cf.*obliquus*、*Hesofavosites* aff.*tchergaensis*、*Dnestrites* spp.、*Dnestrites stylifer*、牙形石 *Panderodus*,*Icriodus angustoides*、腕足类 *Protathyrisina gashaomiaoensis*、*Atrypoidea foxi* 等,时代为晚志留世,生活环境应为阳光充足的温暖浅海(张超,2013).查干哈达组(D_1c)含有大量的珊瑚、腕足、苔藓虫和牙形刺化石.王家街组(D_2w)为富含火山岩夹层的海陆交互相碎屑沉积到海相碳酸盐岩沉积,下段为粉砂岩、长石砂岩夹凝灰岩、火山角砾岩和灰岩,含珊瑚 *Favosites* cf.*goldfussi*、*Thamnopora yangi*、*Syringopora schmidti major*、层孔虫 *Dendroella* sp.、*Stachyodes berticulata* 等;上段为生物屑灰岩、白云质灰岩夹泥质灰岩和燧石结核,含层孔虫 *Actinoroma*,*Dendroella wangjia jieensis*、珊瑚 *Sociophyllum semiseptatum*、*Pachyfavosites* sp.、*Squameofavosites* sp.、*Amphiporaangua* 等,时代为中泥盆世.岩性和生物组合特征说明该地区在中志留世—泥盆纪沉积环境主体为弧背盆地(岩浆弧).

石炭纪—早二叠世,本区主要沉积了一套台地碳酸盐建造,顶部局部见有陆缘碎屑岩建造及海相火山岩建造.磨盘山组($C_{1\text{-}2}m$)属较稳定的台地碳酸盐岩沉积,含晚石炭世早期的植物 *Neuropteris gigatea*、牙形刺 *Declinogathodus noduliferus*(彭玉

鲸和郑春子,1991)、䗴类 *Fusulina-Fusulinella* 组合、*Profusulinella-Eofusulina* 组合、*Eostaffella-Pseudostaffella* 组合、珊瑚 *Opphyllum-Cystolongsdaleia* 组合(黄柱熙,1988).刘建峰(2009)认为本巴图组(C_2bb)火山岩富集 Rb、Ba、K 等大离子亲石元素而亏损 Nb、Ta 等高场强元素,显示了岛弧或活动大陆边缘等与俯冲作用有关的火山岩的地球化学特征.综上所述,该地区在石炭纪－早二叠世仍为弧背盆地(岩浆弧)环境.

从中二叠世开始,随着洋盆的持续收缩,在盘石－百里坪和下二台－呼兰地区沉积了中二叠统陆缘碎屑岩夹海相火山岩建造(大河深组、范家屯组和庙岭组)及上二叠统磨拉石建造(开山屯组和杨家沟组).庙岭组(P_2m)为一套海相硅质火山碎屑岩局部夹中性、酸性熔岩及粉砂岩和灰岩扁豆体,灰岩中含有大量的生物化石,䗴类 *Kahlerina*、*Skinnerina*、*Schwagerina*、*Pseudofusulina*、*Chusenella*、*Verbeekina*、*Neoschwageriana*、*Yabeina*、*Rauserella*、*Jilinella*、*Codonofusiella*、*Dunbarula* 等.以 *Yabeina*、*Codonofusiella* 丰富为特点,称为 *Yabeina-Codonofusiella* 带(孙恒元,1988;吉林省地矿局,1997),时代为中二叠世晚期.晚二叠世海水完全退出,沉积了一套磨拉石建造.在盘石－百里坪和下二台－呼兰地区中－晚二叠世为残余海盆演化.在其他地区沉积了三面井组($P_{1-2}sm$)、额里图组(P_2e)和于家北沟组(P_2y),总体为一套火山岩－含火山物质的沉积岩建造组合,含丰富的䗴类、腕足类、珊瑚及植物化石(江小均等,2011),继续弧背盆地(岩浆弧)演化.

2　构造－沉积演化

古亚洲洋一般指古生代存在于西伯利亚板块与华北、塔里木板块之间的一个浩瀚的古大洋.古生代地壳的形成与演化,主要表现为洋盆的打开与关闭,被古洋盆分割的陆块逐渐汇聚为统一的大陆(李锦轶,2004).在这一洋－陆构造格局的演化过程中,准噶尔地块、华北板块从古生代早期开始,依次拼合到西伯利亚古陆的边缘.

额尔齐斯结合带为西伯利亚板块与准噶尔－哈萨克斯坦板块接合部位(成守德和徐新,2001),为讨论方便,本文将其定义为古亚洲洋的西段.索伦山－西拉木伦结合带、包尔汗图－白乃庙弧盆系位于西伯利亚板块、华北板块之间,属古亚洲洋的东段(李益龙等,2012).笔者通过整理西段与东段古生代地层的沉积序列,对西段和东段的构造－沉积演化形成粗浅的认识(图 5).

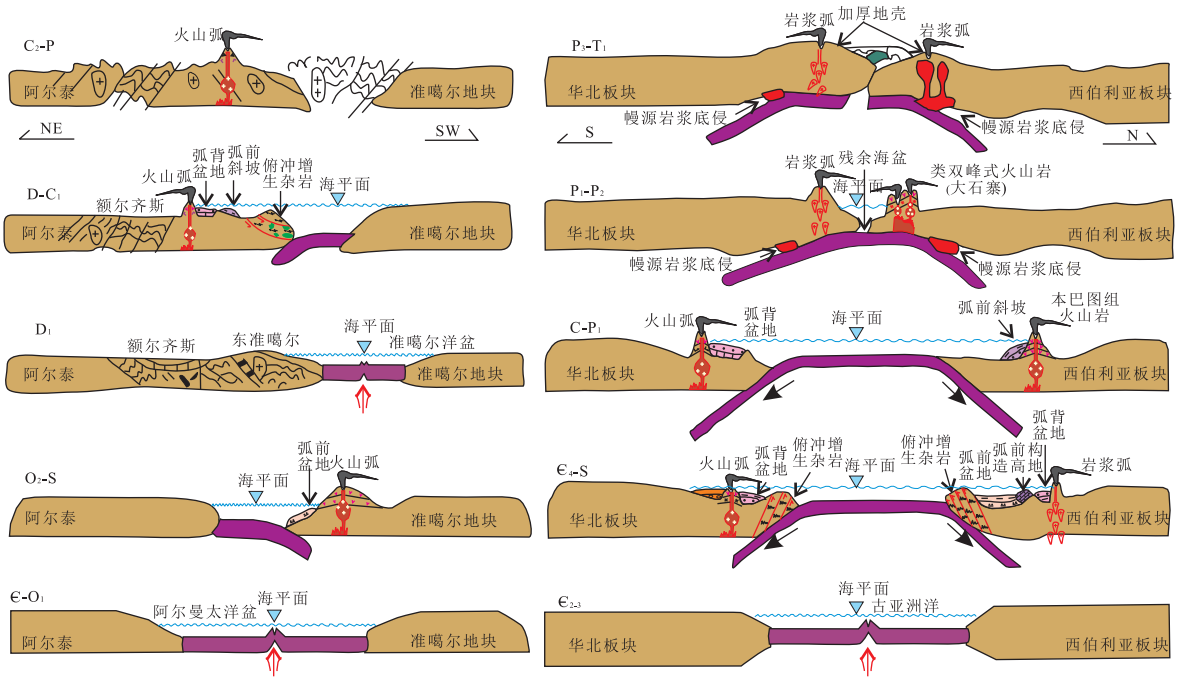
2.1　早古生代－早石炭世古亚洲洋俯冲演化

古生代古亚洲洋盆的构造格局为洋盆与微小陆块相间分布.研究区早古生代为古亚洲洋的一部分,总体表现为洋中脊扩张,并向两侧俯冲消减的过程.

研究区西段:寒武纪－志留纪,古亚洲洋发育和初始主碰撞结束,古亚洲洋向南俯冲,在研究区西段最早的洋盆记录出现于寒武纪(刘伟和张湘炳,1993;黄萱等,1997;简平等,2003;肖文交等,2006),研究区内几条不同的蛇绿混杂岩带或地体结合带也多出现早古生代洋盆记录(何国琦等,2001;金成伟等,2001;朱永峰和徐新,2006;张元元等,2010,张越等,2012),蛇绿岩在晚寒武世－早奥陶世已经形成,表明在早古生代早期古亚洲洋发生洋内俯冲作用.

泥盆纪－早石炭世是晚古生代古亚洲洋西段最后消亡的主碰撞阶段,这一阶段是洋壳的最终消失和蛇绿岩套最终就位的时期(吴波等,2006;王玉往等,2011).早泥盆世,古亚洲洋继续向南俯冲,与此同时,准噶尔洋向北俯冲,结合西段具有与岛弧密切相关的下－中泥盆统拉斑和钙碱系列中基性火山岩,说明其总体处于大洋板块俯冲初期的挤压状态.晚泥盆世江孜尔库都克组的火山岩主要为中性,基性火山岩所占的比例已经很少,而且火山岩为钾玄岩系列,说明此时岛弧已经演化为成熟阶段(张招崇等,2007).而晚泥盆世－早石炭世地层总体表现出稳定的海陆交互相－浅海的碎屑岩－碳酸盐岩沉积加少量火山岩建造,反映洋盆俯冲增生作用至少是从早志留世开始,形成俯冲增生杂岩带－弧前斜坡－弧背盆地等盆地类型.

研究区东段:早中寒武世,在古亚洲洋扩张中脊形成了温都尔庙群蛇绿岩(Xiao *et al*.,2003).从晚寒武－早奥陶世开始,古亚洲洋板块北部向西伯利亚板块俯冲,南部向华北板块俯冲,北侧白音宝力道俯冲增生杂岩带和南侧温都尔庙俯冲增生杂岩和白乃庙岛弧形成.何国琦和邵济安(1983)在西拉木伦河一带从与枕状熔岩伴生的硅质岩及灰岩夹层中发现有属于奥陶纪的介形虫、有孔虫、小腕足类、放射虫及牙形石等化石,从而认为蛇绿岩形成的时代是早古生代,在南侧形成富含火山岩夹层的海陆交互相到浅海相碎屑沉积或不连续的海相碳酸盐岩的弧背盆地沉积.泥盆纪洋盆继续向两侧俯冲,形成弧前构造高地－弧背盆地,接受沉积.



(a) 古亚洲洋西段 (b) 古亚洲洋东段

图 5 额尔齐斯—西拉木伦古生代构造—沉积演化示意

Fig.5 Sketch map of the Paleozoic tectonic-sedimentary evolution of Ertix-Xar Moron area

2.2 早、晚石炭世之交的碰撞演化阶段(西段)

早石炭世晚期,由于板块不断地漂移,西伯利亚和准噶尔两大板块发生碰撞对接,沿额尔齐斯断裂带南北两侧形成了北准噶尔和南阿尔泰两个碰撞造山带.研究区西段早石炭世岩浆岩体系(侵入岩和火山岩)仍具有岛弧岩浆特点,与晚石炭世的后造山伸展岩浆系列呈现出较大反差,表明早晚石炭世之交俯冲作用结束,发生碰撞,洋盆最后闭合.

2.3 晚石炭—二叠世俯冲碰撞(东段)及碰撞后(西段)演化阶段

晚石炭世—中二叠世,研究区西段整体表现为后造山的伸展环境,广泛发育伸展 A 型花岗岩,进入后碰撞演化阶段.盆地类型由弧背盆地演化为弧内裂陷盆地.晚石炭世巴塔玛依内山组火山岩为陆相火山岩,且其地球化学性质表明为大陆板内环境,说明此时西伯利亚板块和准噶尔板块已结束碰撞.刘国仁等(2008)对额尔齐斯构造带中片麻岩进行主量元素、微量元素分析及锆石 U-Pb SHRIMP 年龄测定,表明该处片麻岩为后碰撞阶段岩浆活动的产物,$^{206}Pb/^{238}U$ 谐和年龄为 326±6 Ma,为石炭纪构造—岩浆活动的产物.关于该期的构造背景,前人主要有两种截然不同的认识,即地壳伸展(裂陷)(肖序常等,1992;何国琦等,1994)和板块会聚挤压(岛弧)(马瑞士等,1993).近年获得的花岗岩锶和钕同位素资料均显示出幔源的特点(韩宝福等,1999),证明新疆北部晚石炭世至二叠纪期间处于陆内伸展裂陷的动力学环境,也有来自幔源的岩浆侵入地壳.

研究区东段:石炭纪—早二叠世,古亚洲洋板块向两侧地块的俯冲加强,在华北板块北缘侵位了大量具火山弧性质的侵入岩,形成白音宝力道晚期弧岩浆岩.伴随着岩浆的侵位,在地表处可能有强烈的火山喷发,在北侧表现为本巴图组火山岩.向南过渡到弧前斜坡环境中本巴图组的主体——浅海相碎屑沉积岩系,晚石炭世晚期,岩浆活动趋于平静,区域上形成了以海相碳酸盐岩为主的阿木山组地层.在早二叠世早期,温都尔庙、白音宝力道等地层抬升接受剥蚀,于弧背盆地中迅速沉积,向北俯冲的古亚洲洋板片发生后弯,形成索伦蛇绿岩(Jian *et al.*,2008).内蒙古中、东部地区中二叠世晚期放射虫的发现,表明该时期华北板块与西伯利亚板块间仍存在深水盆地,从古生物学上进一步证实两大板块的最终拼合至少发生在中二叠世末以后.同时,分布于索伦至锡林浩特一线的哲斯组深水沉积,指示了两大板块最后拼合应位于林西地区(尚庆华,2004).晚二叠世,华北地台与西伯利亚地台两侧的双壳类、叶肢介、植物群落等在大兴安岭地区发生混生现象(张永生等,2012)及同期陆间残余洋盆地出现,表明古亚洲洋构造域已发生重大改变,洋盆的闭合导致索

伦缝合带的最终碰撞缝合.刘永江等(2010)通过对索伦、林西地区林西组砂岩碎屑锆石的同位素定年和物源分析,发现与华北板块标志性构造事件年龄一致的约 1 800 Ma 和约 2 500 Ma 两组明显的锆石年龄峰值,推断林西地区沉积时可能有来自其南侧华北板块北缘地区的物源供给.王惠初等(2007)通过对冀北地区晚古生代钙碱性侵入岩变形变质特点的分析,结合其他变质作用的时代依据,推测古亚洲洋的封闭不晚于二叠纪末.孙德有等(2004)认为大玉山花岗岩体形成于 248 Ma 左右的二叠纪末期,岩浆来源于加厚地壳底部基性玄武质岩石的部分熔融作用,属同碰撞型花岗岩,是板块碰撞拼合的直接岩浆岩证据,说明西拉木伦－长春－延吉缝合带于二叠纪末期发生了最终的碰撞拼合作用.

由于古亚洲洋的消亡总体转为陆相环境,三叠纪早－中期磨拉石沉积的出现和同期岩浆活动的发生,标志着该区强烈碰撞造山作用的发生和碰撞过程的结束.

3　结论

(1)额尔齐斯－西拉木伦对接带古生代盆地演化过程:①早古生代－早石炭世古亚洲洋俯冲阶段,西段:随着洋盆不断俯冲,奥陶－志留纪为弧前盆地沉积;泥盆纪－早石炭世转为俯冲增生杂岩带和弧背盆地沉积.东段:随着洋盆向南北两侧双向俯冲,北侧寒武纪－奥陶纪为含蛇绿岩的俯冲增生杂岩带,末志留世－早石炭世为弧背盆地和弧前构造高地沉积.南侧寒武纪－早石炭世为温都尔庙俯冲增生杂岩带、弧背盆地及弧后盆地沉积;②早、晚石炭世之交的碰撞演化阶段,西段:晚石炭世进入弧内裂陷盆地演化.东段:北侧晚石炭世转为弧前斜坡、弧－海山增生带,南侧仍为弧背盆地沉积;③晚石炭－二叠世碰撞及碰撞后演化阶段,西段为弧内裂陷盆地.东段:局部洋盆沉积,中晚二叠世,进入残余海盆演化阶段.

(2)古亚洲洋的闭合由西向东呈“剪刀式”,时间分别为早石炭世末和中二叠世－早三叠世.

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