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西藏山南地区上三叠统复理石郎杰学群岩性分布样式及其意义①

张朝凯[1] 李祥辉[1] 王 尹[2] 孙 勇[3]

(1. 南京大学地球科学与工程学院 南京 210046; 2. 江苏省有色金属华东地质勘查局八一四地球物理勘查公司 南京 210000; 3. 四川省地矿局区调队区调所 成都 610213)

摘 要 对西藏山南地区雅鲁藏布江以南的上三叠统复理石郎杰学群进行了野外地质调查,完成了 14 条地质路线调查和 65 个点的观测,重点统计了露头观测点陆源碎屑岩各种岩性的厚度。根据不同岩性(反映粒度大小)的厚度统计对每个观察点上的砂岩与(粉砂质)板岩厚度的比例进行了计算,将砂岩/板岩比值投点到平面图上,编绘出不同层位的砂岩/板岩比值等值线图。结果表明,绝大部分层位的砂岩/板岩比值呈现由北向南变小的变化,反映了向南粒度变细的趋势;这一变化趋势与过去发表的由北而南古水流格局所反映的物源来源具有相同涵义,进一步支持并夯实了郎杰学群系北部来源而非印度大陆(特提斯喜马拉雅)来源的科学认识。物源来源和东西部砂岩/板岩比值的大小差异还暗示郎杰学群至少有两个主流物源方向和两个叠合的海底扇沉积体系。

关键词 物源 沉积物分散样式 砂岩/板岩比值 郎杰学群 上三叠统 西藏南部

第一作者简介 张朝凯 男 1988 年出生 博士研究生 古生物学与地层学 E-mail: zck198810@126.com

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0 引言

西藏南部沿雅鲁藏布江以南大面积出露一套上三叠统中低级变质的深海—半深海复理石沉积地层,过去分别称为郎杰学群和涅如组。由于二者各方面特征极为相似,因此新近研究建议把涅如组归并为郎杰学群的一个组[1]。本文的郎杰学群即采用此种合并方案,包括了山南地区的涅如组。

长期以来这套复理石在构造和盆地分区上被归于特提斯喜马拉雅(次深海)低分水岭[2]或北亚带[3,4],亦即被归属印度次大陆北部稳定大陆边缘的建造[5~10](图 1)。另外一种认识通常把郎杰学群与日喀则以西构造混杂的修康(岩)群一起当做缝合带的混杂堆积建造[11,12]。虽然早先有人对此观点产生了质疑[13],但并没有直接证据,直到近期才从泽当南部琼结县一带的碎屑组分、古水流、地球化学[14~16]、钐钕同位素[17],仁布地区的重矿物[18]、碎屑组分[19,20]、Hf 同位素及碎屑锆石年代学[21]等方面证实郎杰学群的物质组分非印度大陆来源。

但是,上述研究主要集中于仁布和琼结等局部地区,研究范围相对局限;其二,虽然研究方法和手段包括了碎屑组分、古水流、全岩地球化学、碎屑锆石年代学,但沉积学方面仍有欠缺。为了更全面系统地认识这套地层的物源情况,近期,我们对这套复理石进行了野外地质调查,研究范围从西部的浪卡子县到东部隆子县的扎日乡,几乎涉及到了郎杰学群分布的大部分。本文重点通过野外地质路线观察点的砂岩、粉砂岩、板岩厚度统计,分析其变化趋势,试图进一步检测过去工作的代表性,为更广区域的大地构造划分和物源分析提供沉积学证据。

1 沉积特征与研究方法

西藏山南地区上三叠统郎杰学群主要包括涅如组、宋热组、江雄组、姐德秀组[1],各组均呈断层接触。虽然区域地质图中大多区分了这几个组,但实际野外操作存在较大困难。它们总体上以板岩、砂岩、粉砂岩为主,主要呈现灰色、绿灰色。其中,砂岩主要为长石(石英)砂岩或岩屑(石英)砂岩,碎屑颗粒次棱角—次圆状,分选较差,结构和成份成熟度均较低。砂岩和粉砂岩多呈中—薄层产出,次见厚层,岩层中常见水平层理、砂纹层理、平行层理、块状及粒序层理,中粒、粗粒砂岩底部可见槽模和沟模构造。上述

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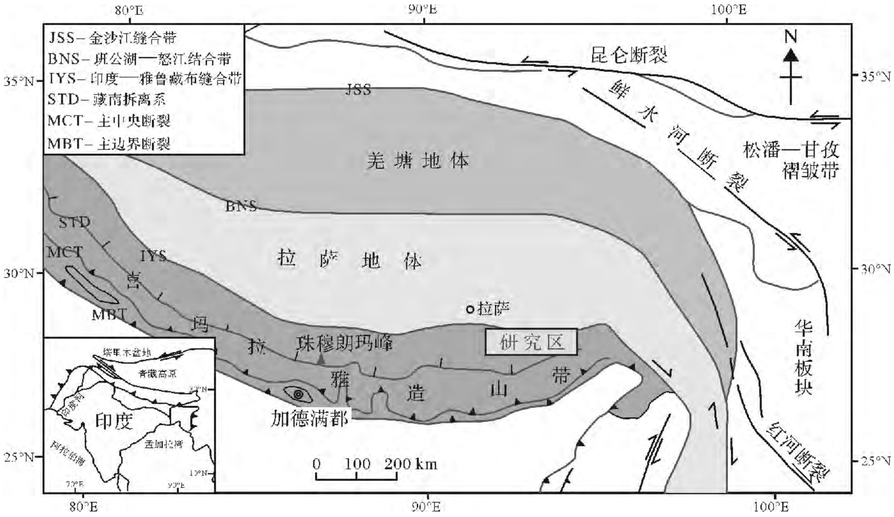

图 1　西藏大地构造略图及研究区位置(据 Searle, *et al.*, [2] 简化)

Fig. 1　Study area within Tibet tectonic sketch map (simpified from Searle, *et al.* [2])

三种岩石多以互层产出并构成鲍马序列,但结构往往不完整,以 A-C、B-C、C-E、D-E 组合为主; 郎杰学群总体表现为海底扇沉积模式,从底部的外—中扇砂板岩相往上演化为中—内扇砂板岩含砾岩相[14]。

根据以上郎杰学群的沉积特征,我们设计了岩性类型(反映粒度)分布方法来分析其物源方向。这是因为,碎屑沉积物的分散样式是研究物源和古水系的一个重要方法,其原理是: 水系通过的区域是砂体最为发育的地区,具有砂岩厚度大、砂岩含量高的特点[23];通常离物源区越远,沉积物粒度越细。在具体操作上,根据地层分布主要呈东西向带状展布特征,我们系统布置了 14 条近南北向地质路线,完成了 65 个点的观测记录(图 2),对每个观测点的砂岩、(泥质)粉砂岩、(粉砂质)板岩的厚度分别进行统计。然后,将各种岩石类型(可代表粒度大小)厚度进行累计,对每个观察点上的砂岩与(粉砂质,以下省略)板岩累积厚度的比例进行了计算,将砂岩/板岩比值投点到平面图上,从而编绘不同层位的砂岩/板岩比值等值线图,由此来判别碎屑粒度大小的变化趋势。野外观测点统计总厚度均剔除了断层和褶皱引起的地层重复,一般真厚度累积都大于 50 m,大多总厚度在 80 ~200 m(表 1)。这些观测点数量和统计厚度基本上可以满足平面上粒度变化趋势分析需要。

2　数据结果

数据统计结果参见表 1。从砂岩/板岩比值等值线图可以看出,浪卡子县附近涅如组的砂岩/板岩比值都比较小,从 0.12 向南降到 0.01(图 2a),说明这一地区涅如组主体为板岩。而在隆子县,涅如组不仅分布范围较广,而且砂岩/板岩比值从北向南、从东向西减小的趋势特征明显。如在雪萨乡附近,该值从 2.4往南减小到 0.6; 向东在雪萨和扎日乡之间,砂岩/板岩比值往西南方向变小,比值从 25.0 降到 2.0 左右(图 2a)。

宋热组分布于仁布县与曲松县之间,呈东西向展布,其砂岩/板岩比值等值线如图 2b 所示,总体也是由北向南减小的,最西部从北边的 1.0 向南逐渐递减到 0.2,而中部和东部都是从 0.6 左右减小到 0.1 左右,总体西部比值比东部比值稍大。

江雄组主要分布于宋热组以北及其东南。鉴于樟村组 T_3z,玉门组 T_3y 南北向出露较窄,以组为单位不能准确表现出等值线关系,所以其砂岩/板岩比值等值线未在图 2e 中显示。如图 2c 所示,在琼结—贡嘎之间的该组砂岩/板岩比值也是从北向南递减,西部总体比东部的比值大: 最西部从 1.89 向南降到0.22,中部从北的2.0 向南降到0.4,东部大致从0.8向南降到0.4 左右。其中,有个别比值较大的观察点。

姐德秀组主要沿雅鲁藏布江分布于贡嘎、扎囊一带,虽然出露范围较窄,但砂岩/板岩比值也反映出一定的分布规律。如图 2d 所示,砂岩/板岩比值从最北边的 1.5 向东南和西南方向分别逐渐减小到0.5 和0.8。

3　讨论与结论

(1) 岩性分布样式之物源来源意义

整体来看,各组砂岩/板岩厚度比值所反映的古

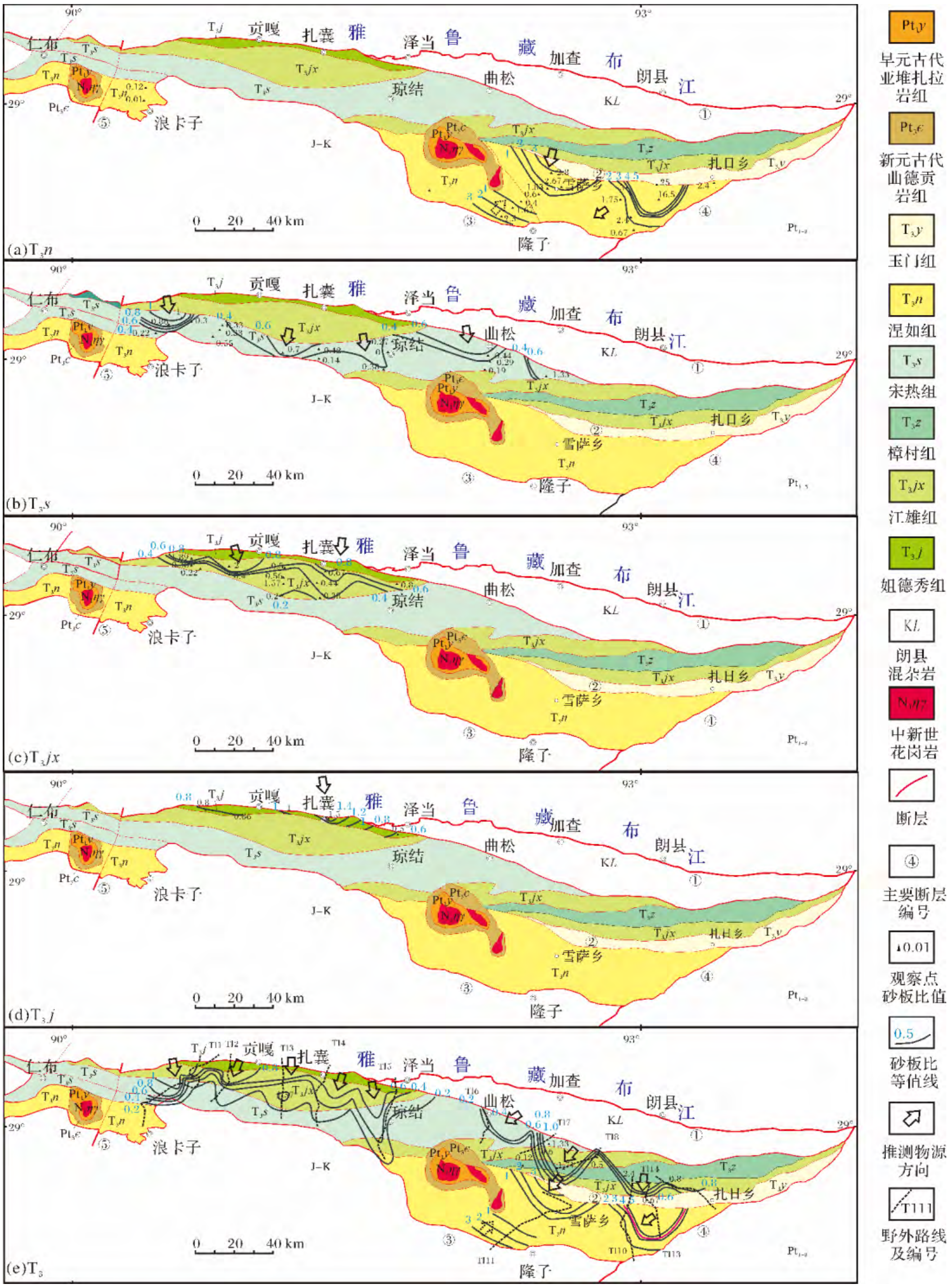

图2 西藏南部上三叠统郎杰学群各组之砂岩/板岩比等值线及物源方向图

(地层及构造背景底图据1∶25万区域地质图简化。这些地质图包括拉萨市幅和泽当镇幅(西藏自治区地质调查院,2006)、日喀则市幅(西藏自治区地质调查院,2002)、隆子县幅和扎日区幅(云南省地质调查院,2004.12))除涅如组等值线间距为1外,其他各组中等值线间距为0.2。①乃东—桑日—加查—朗县断裂;②邛多江—扎日断裂;③仁布—张达—隆子断裂;④错那—米林断裂;⑤羊八井—穷堆断裂。

Fig. 2 Ratio isoline map of sandstone vs. slate in thickness for the formations of the Upper Triassic Langjiexue Group in southern Tibet

The ratio isoline interval is designed as 1 for the Nieru Formation, and as 0.2 for other formations. ①Naidong-Sangri-Jiacha-Langxian fault; ②Qiongduojiang-Zhari fault; ③Renbu-Zhangda-Longzi fault; ④Cuona-Milin fault; ⑤Yangbajing-Qiongdui fault.

表 1　西藏南部上三叠统郎杰学群各组观察点之岩性厚度及其比值信息统计

Table 1　Statistics of sandstone vs. slate thickness ratio and individually lithological thickness for formations of the Upper Triassic Langjiexue Group at each observation site in southern Tibet

观察点	层位	碎屑岩厚度及含量						统计厚度/m	砂岩/板岩厚度比
		板岩/m	含量/%	粉砂岩/m	含量/%	砂岩/m	含量/%		
TL1-01A	T_3n	196.5	98.3	1.5	0.8	2	1.0	200	0.01
TL1-01B	T_3n	85	85.0	5	5.0	10	10.0	100	0.12
TL1-01	T_3x	90	75.0	10	8.3	20	16.7	120	0.22
TL1-02	T_3s	35	43.8	15	18.8	30	37.5	80	0.86
TL1-03	T_3s	120	40.0	60	20.0	120	40.0	300	1.00
TL1-04	T_3s	50	50.0	35	35.0	15	15.0	100	0.30
TL1-05	T_3s	45	75.0	5	8.3	10	16.7	60	0.22
TL1-06	T_3jx	40	57.1	15	21.4	15	21.4	70	0.38
TL1-07	T_3jx	45	30.0	20	13.3	85	56.7	150	1.89
TL1-08	T_3j	50	50.0	10	10.0	40	40.0	100	0.80
TL2-01	T_3s	55	55.0	15	15.0	30	30.0	100	0.55
TL2-02	T_3s	30	60.0	10	20.0	10	20.0	50	0.33
TL2-03	T_3s	15	50.0	10	33.3	5	16.7	30	0.33
TL2-04	T_3jx	50	62.5	10	12.5	20	25.0	80	0.40
TL2-05	T_3jx	25	25.0	25	25.0	50	50.0	100	2.00
TL2-06	T_3j	35	35.0	35	35.0	30	30.0	100	0.86
TL3-01	T_3s	50	50.0	15	15.0	35	35.0	100	0.70
TL3-02	T_3jx	75	75.0	10	10.0	15	15.0	100	0.20
TL3-03	T_3jx	35	35.0	10	10.0	55	55.0	100	1.57
TL3-04	T_3jx	45	56.3	10	12.5	25	31.3	80	0.56
TL3-05	T_3jx	30	60.0	5	10.0	15	30.0	50	0.50
TL3-06	T_3j	60	40.0	30	20.0	60	40.0	150	1.00
TL4-01	T_3s	70	70.0	20	20.0	10	10.0	100	0.14
TL4-02	T_3s	120	60.0	30	15.0	50	25.0	200	0.42
TL4-03	T_3jx	200	66.7	25	8.3	75	25.0	300	0.38
TL4-04	T_3jx	180	60.0	40	13.3	80	26.7	300	0.44
TL4-05	T_3jx	15	50.0	5	16.7	10	33.3	30	0.67
TL4-06	T_3j	10	33.3	5	16.7	15	50.0	30	1.50
TL5-01	T_3n^2	65	65.0	15	15.0	20	20.0	100	0.31
TL5-02	T_3jx^1	200	66.7	30	10.0	70	23.3	300	0.35
TL5-03	T_3s^2	130	65.0	20	10.0	50	25.0	200	0.38
TL5-04	T_3s	90	90.0	10	10.0	0	0.0	100	0.00
TL5-05	T_3s	150	75.0	10	5.0	40	20.0	200	0.27
TL5-06	T_3jx	50	50.0	10	10.0	40	40.0	100	0.80
TL5-07	T_3j	60	60.0	10	10.0	30	30.0	100	0.50
TL6-01A	T_3jx	25	83.3	1	3.3	4	13.3	30	0.16
TL6-01B	T_3s^2	80	80.0	5	5.0	15	15.0	100	0.19
TL6-02	T_3s^1	35	70.0	5	10.0	10	20.0	50	0.29
TL6-03	T_3s	18	60.0	4	13.3	8	26.7	30	0.44
TL7-01	T_3jx^1	25	50.0	10	20.0	15	30.0	50	0.60
TL7-02	T_3s^3	15	37.5	5	12.5	20	50.0	40	1.33
TL8-01	T_3z	35	35.0	5	5.0	60	60.0	100	1.71
TL8-02	T_3jx^1	30	60.0	5	10.0	15	30.0	50	0.50
TL9-01	T_3z	85	85.0	5	5.0	10	10.0	100	0.12
TL10-01	T_3jx^2	50	25.0	30	15.0	120	60.0	200	2.40
TL10-02	T_3s	15	30.0	5	10.0	30	60.0	50	2.00
TL10-03	T_3n^2	10	20.0	10	20.0	30	60.0	50	3.00
TL10-04	T_3n^1	20	33.3	5	8.3	35	58.3	60	1.75
TL10-05	T_3n^3	25	25.0	15	15.0	60	60.0	100	2.40
TL10-06	T_3n^1	60	40.0	50	33.3	40	26.7	150	0.67
TL11-01	T_3n^3	30	30.0	15	15.0	55	55.0	100	1.83
TL11-02	T_3n^2	25	50.0	10	20.0	15	30.0	50	0.60
TL11-03	T_3n^1	25	62.5	5	12.5	10	25.0	40	0.40
TL11-04	T_3n^2	15	30.0	10	20.0	25	50.0	50	1.67
TL11-05	T_3n^1	20	20.0	30	30.0	50	50.0	100	2.50
TL11-06	T_3n^3	3	20.0	4	26.7	8	53.3	15	2.67
TL11-07	T_3n^2	25	25.0	5	5.0	70	70.0	100	2.80
TL12-01	T_3n^2	85	85.0	5	5.0	10	10.0	100	0.12
TL13-02	T_3jx^2	45	56.3	5	6.3	30	37.5	80	0.67
TL13-03	T_3y	25	83.3	4.5	15.0	0.5	1.7	30	0.02
TL13-04	T_3n^2	1	3.3	4	13.3	25	83.3	30	25.00
TL13-05	T_3n^1	2	5.0	5	12.5	33	82.5	40	16.50
TL14-01	T_3n^1	50	25.0	30	15.0	120	60.0	200	2.40
TL14-02	T_3y	1	5.0	4	20.0	15	75.0	20	15.00
TL14-03	T_3jx^2	10	50.0	2	10.0	8	40.0	20	0.80

注: (1) 各组代号参见图 2; (2) 砂岩/板岩厚度比值实为砂岩/(粉砂质泥岩)之比。

水系方向比较一致，主体上都由北而南，表明物源方向来自北侧，而不是南侧。这一推断结果与早先在琼结、郎杰学[1,15]和仁布[20]地区通过古水流和重矿物组合指示[18]的方向来判断的物源认识完全一致，进一步支持了晚三叠世郎杰学群非印度大陆来源的观点。

但是，我们也注意到有二组物源方向和东、西部砂板岩比值大小存在差异的问题。在琼结和浪卡子之间，物源方向主要由北向南，砂岩/板岩比值由北往南主体从1.0降到0.3，且在浪卡子一带涅如组基本上保持在0.1以下；在东部隆子—曲松—扎日之间，物源方向指示主体由北东向南西方向，涅如组中砂岩/板岩比值变化较大，由北往南从3.0降到1.0，甚至最东部还从25.0降到2.0(图2)。我们认为，这种差别暗示至少在测区有两个主要的物源区来源，而且可能北东方向离物源区更近。但也不排除岩相的变化引起，也即是北东方向高砂岩/板岩比值可能是水道亚相发育的产物，这需要更进一步的工作予以证实。这样看来，即使物源方向业已确定，但尚有其它诸多因素影响如地层格架、物源类型、供给量、盆地形状等随时间变化及充填深水变化[24]；沉积岩相变化也可是一个关键因素，因为海底扇的内扇比中扇和外扇粒度粗，水道相粒度要比溢流相粗。海平面升降引起的层序单元体系域的进积或退积也会使砂岩/板岩比值变化，但Mattern[25]指出，在构造活动区大陆架窄，扇体对海平面变化没那么敏感。

(2) 岩性分布样式的岩相模式意义

如上，砂板岩比值显示了测区存在二组物源方向和东、西部比值大小不同，不仅可以指示物源区的来源存在差异，而且也反映了岩相模式的变化。从郎杰学群各组中的砂岩/板岩比值等值线形态、比值大小、物源方向配置方式来看，我们认为，山南地区这套复理石建造至少由两个大的海底扇沉积体系组成，如考虑西至仁布一带大面积出露的差异，甚至可能存在三个大型海底扇沉积体系；各个海底扇沉积体系由若干扇体在平面上联合，构成一个叠合的联合扇体系[25]。

可能的问题是，虽然过去的工作已经在琼结地区提出了海底扇的演化模式[14,15]，但各个海底扇沉积体系由多少个扇体叠合而成，是进积还是退积为主的扇体组成，或者多期进积—退积叠加组成等尚不清楚。这不仅需要更为详尽的岩相工作，而且需要进一步厘清地层层序和相互配置关系。在下一步的沉积学工作中，要重点考虑的是水道充填物特别是内扇分布的水道和中扇的分支水道。它们一般显示出复杂的层理样式，充填物在横向和垂向上都随机分布，轴向侵蚀，细层向水道边缘汇聚[25,26]；水道中的古水流方向变化范围较狭窄，砂岩较厚，呈板状或透镜状；天然堤亚相具有古水流方向变化范围大，砂岩薄等特征[27]。

(3) 关于构造变形作用对数据的影响

从图2a和2e中可以看出最南边隆子县附近存

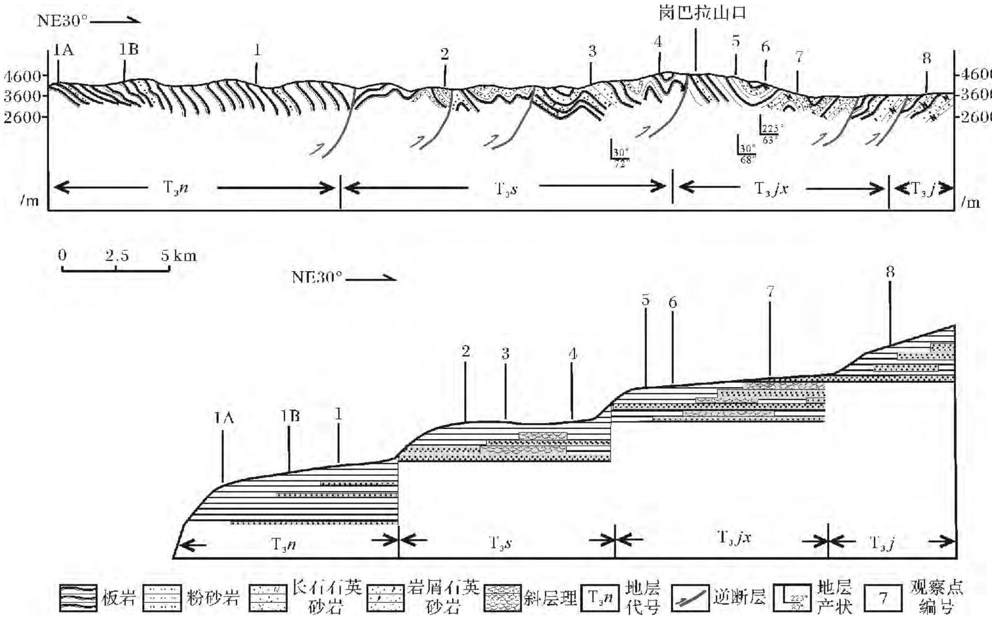

图3 路线TL01信手剖面及构造恢复示意图(地层代号参见图2图例)

Fig. 3 Sketch of the observed profile TL01 and its schematic cross section by tectonic restoration

在与绝大部分地区显示的物源方向不协调的两个数据,等值线变化指示古水系似乎是从南向北。虽然,数据甚少,也可以从水道转弯等来解释这一结果,但地层变形可能也是一个重要因素。原因是,隆子县北侧这两个数据来自涅如组一段(T_3n^1)到涅如组三段(T_3n^3),岩层产状显示地层发生了倒转,因此砂岩/板岩比值表现为由南向北增大。如果把地层恢复到正常状态,古水系方向指示从北向南。可见,这种地层倒转现象可能会对有关观测数据产生影响。

实际野外观察发现,虽然地层倒转时有发生,但在观察点所采集的数据基本上排除了这种构造变形引起的数据反转。基本方法就是通过地质路线编制平衡剖面,将采样点恢复到原始沉积位置,进而查辨这些采样点是否倒转。图3即是一个实例。从该图中可以看出,各采样点恢复到水平状态时各观察点的相对位置是不变的,表明TL01路线上的采样点并没有因为地层变形(如倒转)而发生沉积顺序上的混乱。由此可见,褶皱变形及断层作用造成的南北向位移对于文中各观测点的数据结果影响较小。

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Lithological Distribution of the Upper Triassic Flysch Langjiexue Group in Shannan Region，Southern Tibet：Implications to Provenance and Environment

ZHANG Chao-kai[1] LI Xiang-hui[1] WANG Yin[2] SUN Yong[3]

（1. School of Earth Sciences and Engineering，Nanjing University，Nanjing 210046；
2. 814 Geophysical Exploration Company of East China Mineral Exploration and Development Bureau，Jiangsu Province，Nanjing 210000；
3. Geology Survey，Bureau of Geology and Mineral Resources，Sichuan Province，Chengdu 610213）

Abstract: The Upper Triassic flysch Langjiexue Group is widespread in southern Tibet. It outcrops south to the river Yarlung Zangbo and east to Bailang county，confined by three thrusts：Naidong-Sangri-Langxian Fault in north，Cuona-Milin Fault in east，and Renbu-Zhangda-Longzi Fault in south. A suggestion of the coeval Nieru Formation belonging to the Langjiexue Group may have the southern boundary fault southward extended to the Renbu-Zhangda-Longzi Fault. The Upper Triassic Langjiexue Group has been classified as either a part of the northern deep sea Tethys Himalayas or a component of the melange Xiukang Group——accretionary prism within the Yarlung Zangbo suture since it was nominated. Recent geological investigation on paleocurrent flow direction and provenance analysis of clastic composition and geochemistry demonstrated a different viewpoint from the past，in which lithological distribution has not been established.

A geological field investigation of the Upper Triassic flysch Langjiexue Group was in this work carried out in Shannan region，southern Tibet，south to the river Yarlung Zangbo，during which lithology and thickness of variety of terrigenous rocks were described and calculated at sixty-five outcrop observations within fourteen geological traversal profiles in almost N-S direction. Then the data of the thickness were processed as follow：1）calculating the ratio of sandstone versus slate for every observation——response to clastic grain size distribution and source，a method for purpose of recovery of sedimentary dispersal，paleocurrent system based on the principle of finer grain size if more further transportation；2）projecting ratio value of each observation on the scaled geological map；and 3）editing equal ratio values and draw by isoline on the map for the same formation. It is noted that sandstone in the statistic of thickness，and slate covers the silty and non-silty slate. The sum of thickness is over 50 m，in general 80 m ~ 200 m，at

each observation.

All the data of each observation were optimal by excluding of stratal duplicate. This is because of statistics that could be repeated at two even more observations due to folding and thrusting, etc. for overturn of strata. To avoid this shortage, relative positions of observations were examined by balance section for each profile, and results show no duplicates of observed places happened to the observed places in this work.

The observation of lithology shows there are almost no conglomerates in the Upper Triassic flysch Langjiexue Group, but it is mainly composed of low grade metamorphosed flysch sandstone and slate facies. The strata are comprised by alteration of sandstone/siltstone beds and dark gray to blackish (hemi-) pelagic shale. Sandstones are dominated by medium to fine feldspar / lithic (quartz) sandstone or greywacke with angular - subangular roundness and variable sorting. Lithologies are arranged in an upward fining Bouma sequence, in which graded beddings, parallel cross-beddings, horizontal, and ripples, are common. The sedimentary strata are metamorphosed into variable degree, which is increasing eastward and toward the metamorphic core complex, with the center formed by the Cenozoic granitic pluton. Strong folding and thrusting together with metamorphism and lack of fossils makes the sequences stratigraphically difficult to restore. However, former limited biostratigraphic evidences suggest that the group is of Norian-Rhaetian age.

Isolines of lithological ratios display that ratio values of sandstone vs. slate decrease from north to south in majority of formations: 1) 0.12 to 0.01 of the slaty Nieru Formation in Nagarze, 2.4 to 0.6 near Xuesa village, Lhunze, and 25.0 extremely down to 2.0 between Xuesa and Zhari villages, Lhunze, indicating an discrepancy between east and west of Shannan region and likely development of channels under water; 2) 1.0 to 0.2 of the Songre Formation in western Shannan, and 0.6 to 0.1 in mid Shannan, in which ratios are bigger in western than in eastern Shannan region; 3) 1.89 to 0.22 of the Jiangxiong Formation in western Shannan, 2.0 to 0.4 in mid Shannan, and 0.8 to 0.4 in eastern Shannan, with few exceptances, and it is also bigger in western than in eastern Shannan region; 4) 1.5 to 0.5 ~ 0.8 of the Jiedexiu Formation southeastward and southwestward in Gonggar and Zhanang. Those results above indicate a total tendency of finer and finer grain southward, implicating southward direction of terrigenous matters. This observation is quite consistent with the previously published paleocurrent data, supporting and enforcing the scientific understanding of other origination of the Langjiexue Group instead of the paleo-Indian continent (Tethys Himalaya) in south.

According to lithology and the variation (tendency, isoline shape, and pattern) of ratio values of sandstone vs. slate from east to west, it is proposed that the Langjiexue Group documents the sediments of middle and outer (lobe) submarine fan without inner fan, and there are at least two even more coalescing submarine fan systems during the Late Triassic in Shannan area. Recognition of possible amount and superposition of fans remains much work in future.

Key words: provenance; environment; sediment dispersal; ratio of sandstone vs. slate; Langjiexue Group; Upper Triassic; Shannan; southern Tibet