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重庆万州下侏罗统自流井组湖相遗迹化石新类型及其古环境意义*

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提要 描述在重庆万州区铁峰山下侏罗统自流井组大安寨段首次发现的遗迹化石,鉴定为新种 *Palaeophycus tiefengshanensis*。该种以潜穴表面瘤状凸起特征与较大的潜穴尺寸区别于古藻迹其他遗迹种。遗迹组构分析表明该遗迹化石产出层位的层面生物扰动指数为最高级 5,说明原始沉积环境的食物供给充足,氧含量高,造迹生物大量繁盛并活动频繁。根据沉积相变化特征,四川盆地东部地区自流井组沉积期经历了与四川盆地北部地区类似的古环境变迁即湖退过程。两者区别在于四川盆地东部自流井组局部层段可能更适宜底栖动物生存。

关键词 *Palaeophycus* 遗迹组构 自流井组 下侏罗统 万州

中国侏罗纪遗迹化石报道不多,素材主要来自北方(姚培毅,1984;其和日格,1995;张建平等,2000),在西藏珠峰(林文球等,1982)与阿里地区(杨式溥等,1982)以及四川盆地安岳(阚泽忠等,2005)亦有报道。总结这些成果不难发现,以上研究中沉积相较为多变,既有陆相碎屑岩沉积,也有深海复理石相,亦有海陆交互相与海相。遗迹化石的时代涵盖早、中、晚侏罗世。属种描述主要涉及一些常见的遗迹属,例如 *Planolites*(漫游迹)、*Thalassinoides*(海生迹)、*Scoyenia*(斯考因迹)与 *Skolithos*(石针迹)等。而同样常见的古藻迹(*Palaeophycus*)除上述四川安岳有报道外,未见提及。安岳地区报道的古藻迹时代为晚侏罗世,产于紫红色砂质页岩的小型粉砂岩夹层中,规模较小,仅有简单提及,无具体鉴定特征描述。

2013 年万州一中师生在重庆万州区铁峰山一山路旁发现有大面积出露的遗迹化石(插图 1),经笔者等赴现场调查鉴定为古藻迹(*Palaeophycus*),同时在附近剖面中发现了产出遗迹化石的原始层位为四川盆地早侏罗世地层自流井组上部的标志层介壳灰岩(属于大安寨段),因此确定该古藻迹时代为早侏罗世。该古藻迹为重庆首次发现报道的侏罗纪遗迹化石,也是国内首次发现侏罗纪早期的古藻迹,其规模更是国内之冠。

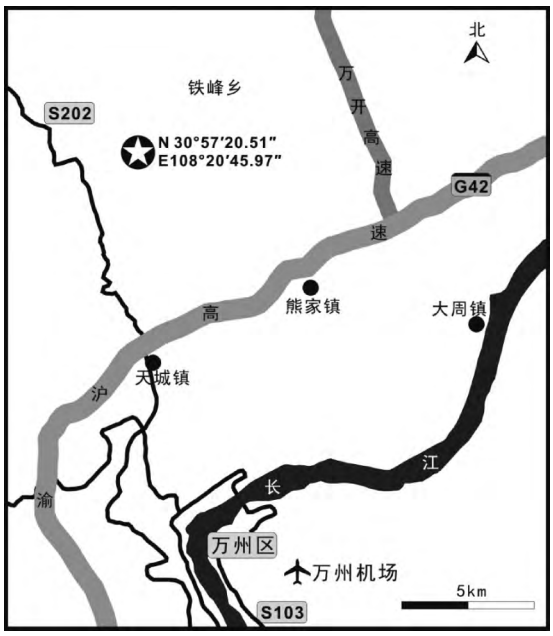

插图 1 重庆万州遗迹化石产地的交通位置图

Regional traffic map and the locality of the studied trace fossils in Wanzhou, Chongqing

星号为化石产地。

The star indicates the site of trace fossil.

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该大规模古藻迹的产出层段大安寨段主要为湖相碳酸盐岩，沉积背景较为特殊，因此具有重要的古环境意义。本文对所发现的遗迹化石进行了系统描述，并对遗迹化石的古环境学意义进行了讨论。

1　区域地质背景与地层

重庆万州位于四川盆地东北部，晚三叠世—始新世主要为陆相碎屑沉积（范昱，2011）。晚三叠世沉积环境开始由海相逐渐演变为海陆交互相，侏罗纪为陆相前陆盆地沉积充填阶段，沉降中心迁移到四川盆地东北端的米仓山与大巴山前缘，河湖相地层厚达 3 000 m 以上。由于后期多次构造运动导致周缘山系差异性的抬升和剥蚀，造成现今保存地层厚度差别较大。下侏罗统自流井组沉积厚度一般为数百米，主要岩性为紫红色泥岩夹薄层石英细砂岩，偶见生物碎屑灰岩或泥灰岩层，常具韵律结构。自下而上分为綦江段、马鞍山段、大安寨段。大安寨段属典型的温暖潮湿气候环境的沉积序列，显示完整的湖侵-湖退旋回，沉积相带呈不对称环形分布。

本文报道遗迹化石所在层位为铁峰山自流井组最上部的大安寨段，该段岩性呈现出“三明治式”特征，可以划分为三部分，上、下均为页岩与薄—中层介壳灰岩互层构成的韵律层，差别在于上部的韵律层介壳灰岩与页岩均较薄，中部为一巨厚层的介壳灰岩。高丰度的遗迹化石分布于下部页岩与介壳灰岩两种沉积物的界面之上，即介壳灰岩的底板之上（插图 2）。铁峰山半山腰路旁的一块介壳灰岩大滚石表面出露面积大约 15 m^2 的遗迹化石，密布于巨厚灰岩的底面，凸出于岩层表面，属于全浮雕保存型式；在该滚石附近亦发现多处此类遗迹化石的巨石块。

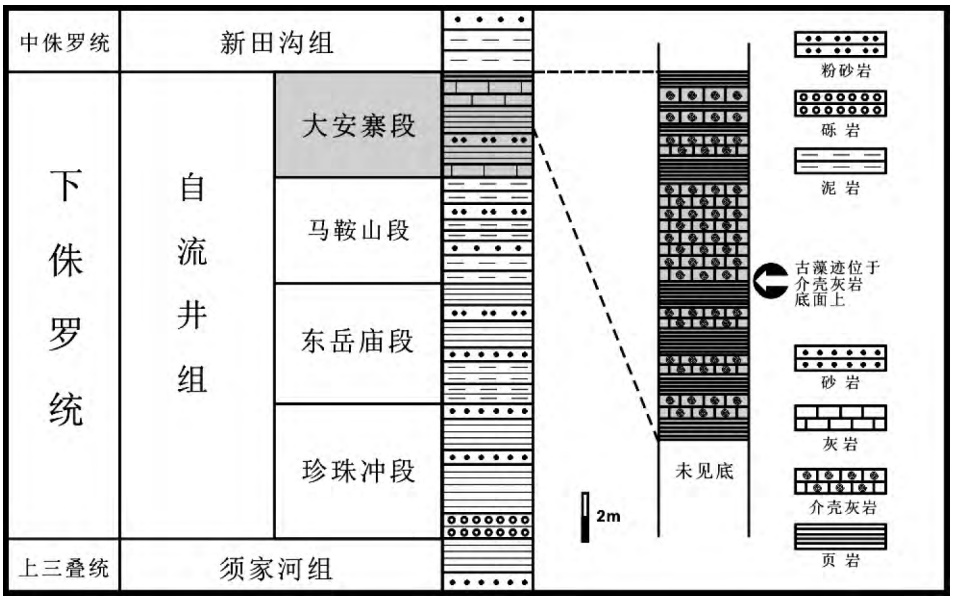

插图 2　重庆万州铁峰乡剖面自流井组地层序列

Stratigraphy of the Ziliujing Formation at the Tiefengxiang section of Wanzhou, Chongqing

2　系统古生物

古藻迹　***Palaeophycus* Hall，1847**

模式种　*Palaeophycus tubularis* Hall，1847

特征　分枝或者更典型的不分枝潜穴，平直到弯曲状，或呈波状弯曲，光滑或有纹饰，具衬里，主要为水平圆柱状潜穴，直径粗细不一；充填物较为均一，岩性与围岩相似。

讨论　文献中描述的古藻迹约有 50 余种（Hall，1847；James，1885；Osgood，1970；Pemberton and Frey，1982），其中有 44 种（约占 85%）为 1847—1883 年间描述，当时将形态仅有细微差别的类型即定为古藻迹新种，其中有许多形态保存不完整。Pemberton 和 Frey（1982）主张古藻迹可以划分为五个种，三种类型即 *P. tubularis*，*P. striatus* 和 *P. heberti* 型。当前在文献中 *Palaeophycus* 常见遗迹种的主要鉴别特征为：（1）潜穴壁光滑，具有明显的衬里，潜穴壁无纹饰：①潜穴壁厚的为 *P. heberti*，②潜穴壁薄的为 *P. tubularis*；（2）潜穴衬里极薄，具有纵向细纹：①潜穴表面具有连续平行纹的为 *P. striatus*，②潜穴表面具有不规则网状细纹

的为 *P. sulcatus*，③潜穴表面具有交替纵细纹和横纹的为 *P. alternatus*（见 Pemberton and Frey，1982）。

古藻迹 *Palaeophycus tiefengshanensis* isp. nov.（插图 3）

词源 种名取自于遗迹化石产地铁峰山。

正模 标本号 WZHS1（保存于重庆市二零八地质遗迹保护研究院）。

特征 水平管状潜穴，微弯曲或不规则弯曲状，潜穴粗大（一般在 6—8 cm），外壁表面具有似泡沫痕状或瘤状小凸起，且表面上普遍分布有介壳。潜穴具衬里，被动充填，充填物成分与围岩相同。

描述 微弯曲或不规则弯曲状的水平管状潜穴，大多平行或略倾斜于层面密集分布，潜穴之间常相互交切。保存潜穴长度多大于 10 cm，少数可达 1 m。潜穴直径 6—8 cm。潜穴外壁表面具有似泡沫痕状或瘤状小凸起。潜穴表面上常分布有介壳，潜穴局部因压实作用而发生变形，横截面为椭圆形，长轴 5—8 cm，短轴 2—3 cm。扁圆柱状遗迹可从围岩中剥离下来，留下管状通道，因此遗迹化石的保存型式为全浮雕。潜穴中充填物质与围岩一致，均为介壳灰岩。

比较 古藻迹是十分常见的遗迹化石，有关古藻迹的报道文献非常之多，本文对众多文献中所报道的古藻迹遗迹种的形态和度量特征进行了总结（表Ⅰ）。

通过对比可以看出，本文报道的古藻迹与已发表古藻迹的形态特征有显著差别，无论是潜穴直径还是潜穴长度都明显大于其余遗迹种，且以潜穴壁不光滑区别于 *P. tubularis*，*P. heberti*，以外表不具有条纹区别于 *P. striatus*，*P. sulcatus*，*P. alternatus*，以不具有不规则斜纹及结节状潜穴形态区别于 *P. wutingensis*。

表Ⅰ 铁峰山古藻迹与已发表的古藻迹种的特征对比

Comparison of characteristics between *P. tiefengshanensis* and published ichnospecies of *Palaeophycus*

遗迹种	参考文献	外表特征描述	潜穴直径（mm）	潜穴长度（mm）	时代
P. sulcatus	（Raghavendra *et al.*，2011）	潜穴具不规则分枝纹	12	150	中新世
P. alternatus	（张立军等，2011）	潜穴具横纹与细纵纹相交错	3—5	＜100	早泥盆世
P. tubularis	（杨式溥等，2004）	潜穴壁光滑，具薄衬里	2—10	12—90	寒武纪早期，晚奥陶世
P. striatus	（杨式溥等，2004）	潜穴壁具纵纹	5—10	70—80	早泥盆世
P. heberti	（杨式溥等，2004）	潜穴壁光滑，具厚衬里	4	50	早奥陶世
Palaeophycus isp.	（杨式溥等，2004）	潜穴壁光滑	4—5	80	早泥盆世
Palaeophycus isp.	（杨式溥等，2004）	潜穴壁光滑	2—4	20—60	寒武纪早期
P. wutingensis	（杨式溥等，2004）	潜穴壁具不规则斜纹潜穴，局部加粗呈结节状	3—10	50	早奥陶世
P. bolbitermilus	（Kim *et al.*，2001）	潜穴具末端膨大	3—12	4—21	志留纪兰多维列世
Palaeophycus isp.	（Chrząstek，2013）	潜穴壁光滑，具衬里	2—9	3.5—4.7	中三叠世
Palaeophycus isp.	（Weber *et al.*，2012）	潜穴壁光滑，具衬里	1—2	5—20	寒武纪
P. tiefengshanensis isp. nov.	本文	潜穴壁粗糙，密布瘤状凸起，具双壳类瓣	55—80	100—1000	早侏罗世

Kim 等（2001）在研究加拿大新不伦瑞克省下志留统 Upsalquitch 组浊积岩遗迹化石时建立一古藻迹新种 *Palaeophycus bolbitermilus*。其显著特征为潜穴末端具有一气泡状凸起。本文所研究的遗迹化石明显区别于 *P. bolbitermiius*。

综合上述对比可以确定本文所研究古藻迹为一新类型，因产于万州铁峰山，定名为 *Palaeophycus tiefengshanensis*。

目前尚无法确定该古藻迹的造迹动物，但从潜穴的长度和直径可以初步判断为体径较大的动物，其造迹动物较以往古藻迹的造迹者尺寸更大。

产地层位 重庆万州区铁峰山，下侏罗统自流井组大安寨段。

3 古环境意义

四川盆地在进入到陆相阶段之后，盆地境内湖泊遍布。前人研究表明该盆地北部早侏罗世时期总

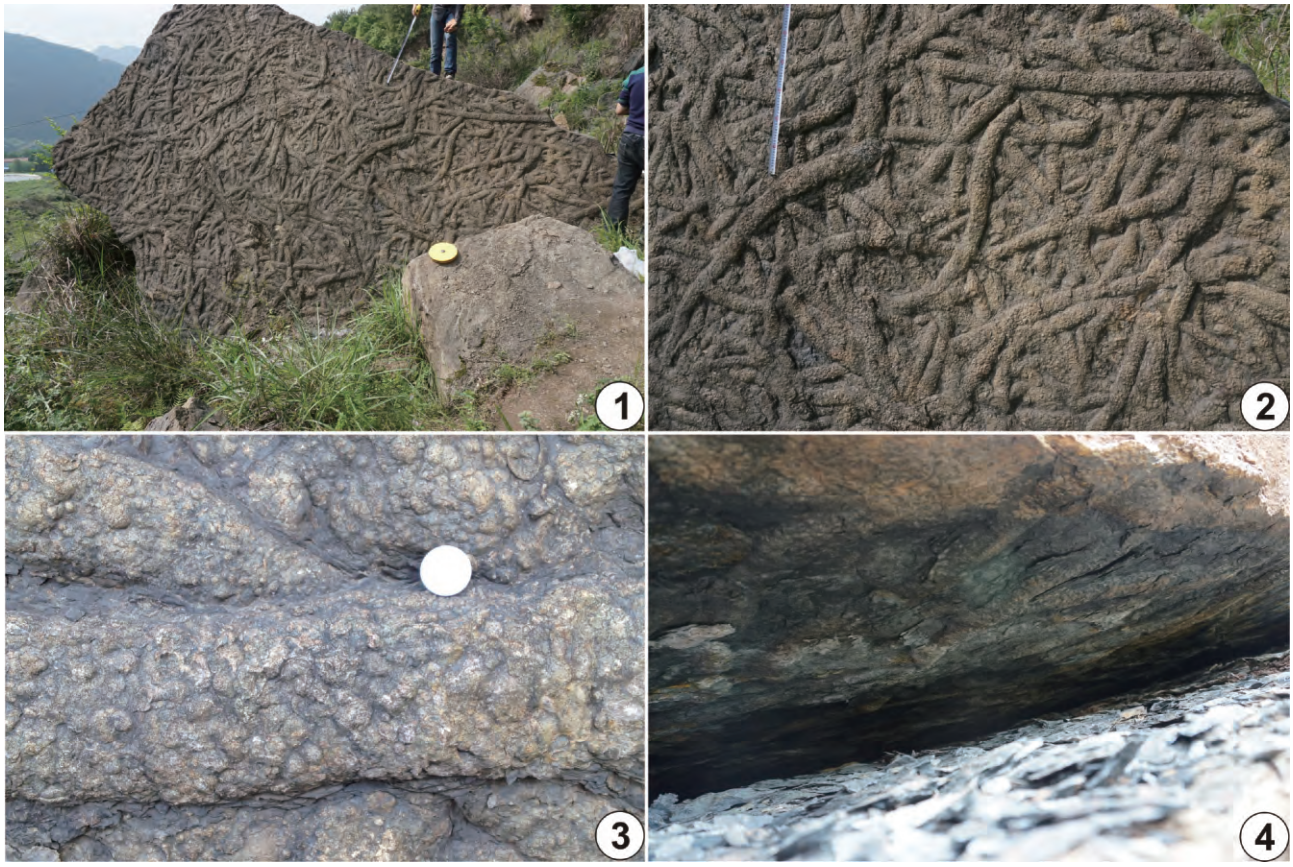

插图 3　重庆万州地区新发现遗迹化石 *Palaeophycus tiefengshanensis* 的野外和切面特征

Field and cross-section features of the newly-found trace fossil *Palaeophycus tiefengshanensis* in Wanzhou, Chongqing

1. 野外总体特征;2. 局部放大特征;3. 示表面保存有双壳类的潜穴大小;4. 遗迹化石以全浮雕的形式保存于介壳灰岩底面。

1. General view of the trace fossils in the outcrop; 2. Enlarged part of the trace fossils shown in 1; 3. Showing the size of the burrow with bivalve shells on the burrow surface; 4. Showing the trace fossil preserved on the sole of shelly limestones as full-relief structures.

体沉积特征为从珍珠冲段沉积晚期到大安寨段沉积早期,湖平面整体处于上升期。大安寨下段沉积时期,发育滨湖或浅湖亚相介壳滩沉积,到大安寨上段沉积时期,浅湖相沉积减少,介壳滩沉积萎缩,滨湖相沉积增多,湖平面开始降低(雍云乔,2013)。而对于盆地其他地区则已有研究较少。本文结合遗迹学证据和沉积相分析对四川盆地东部早侏罗世的沉积环境变化做出进一步推断。

研究区主要发育湖相碳酸盐岩沉积,铁峰乡剖面大安寨下段岩石特征为介壳灰岩与页岩互层,大安寨上段为一套巨厚层介壳灰岩,这表明万州所在四川东部地区在大安寨段沉积时期经历了一次由水体相对较深且平静到水体动荡高能沉积环境的转变即湖退的过程,两者的分界面(介壳灰岩底面)发育这一套密集分布的 *Palaeophycus*。该湖相沉积特点不同于加拿大白垩系边缘湖相(Kim *et al.*, 2005),也不同于河南侏罗系鞍腰组浊积岩(Buatois *et al.*, 1996),同时表明四川盆地东部地区的古地理古环境变化与四川盆地北部地区相一致,从而说明在早侏罗世四川盆地北部与东部的广大地区经历了湖体规模由大到小的变化过程。遗迹化石是判断沉积环境的有效辅助工具(杨式溥,1999),而之前四川盆地北部的研究对遗迹化石有所提及,但限于遗迹化石丰度有限,未有深入研究(雍云乔,2013),本文借助高丰度的遗迹化石,引入遗迹组构的概念对四川盆地东部地区的沉积环境学进行更为细致的分析。

遗迹组构是指由各种生物扰动破坏原生沉积构造所呈现的沉积组构特征,生物扰动包括清晰、可辨认的遗迹化石和无法辨认的生物变形构造(Taylor *et al.*, 2003)。遗迹组构分析特别强调生物扰动与沉积物之间在空间上和时间上的相互关系,因此能够更加精确地解释沉积环境。

之前研究 *Palaeophycus* 遗迹组构表明从海洋的滨外向陆地方向,一般是滨外地区为生物高度扰动地区,因为沉积速率较慢,水动力较弱(陈璐,

2014)。而重庆万州及周边地区自流井组沉积期发育大型湖泊,遗迹化石形成的时候水动力开始动荡,沉积速度加快。

自流井组大安寨段的遗迹组构由单一种组成(*Palaeophycus tiefengshanensis*)。生物扰动指数一般用遗迹组构的纵切面形态衡量,而本文研究遗迹化石主要沿层面分布,所以本文采用层面生物扰动指数(BPBI)(Miller and Smail,1997)来对自流井组中的遗迹化石 *Palaeophycus* 的生物扰动强度进行描述。根据生物扰动的层面覆盖率,可将层面扰动程度划分出 5 个生物扰动级别(表Ⅱ)(Miller and Smail,1997)。不难看出,由于 *Palaeophycus* 几乎完全占据了所在层面且潜穴形态清晰、未形成弥散状生物扰动,因此生物扰动指数属于最高级 5,扰动量为 60%—100%。

根据前人研究,密集分布的遗迹化石往往指示当时沉积环境食物丰富,氧含量高,生物活动频繁(Taylor *et al*.,2003)。因此本文所研究的高丰度遗迹化石表明当时不但有充足的底栖食物供应,而且底层水溶解氧含量也达到了适宜生物生活的浓度。不同潜穴的相互交切和叠覆现象可能表明存在时间均一化效应,即密集分布的遗迹化石可能为一段较长时间内不同期次遗迹化石的叠加,表明造迹动物活动频繁,可能存在一定的沉积间断。潜穴平行于层面分布,其被动填充物主要为介壳灰岩,推断潜穴应为造迹动物在泥质沉积物浅表活动时所营造,是一种水平管状的居住迹,后被介壳灰岩沉积快速充填。因此,本文发育于介壳灰岩底部的古藻迹并非形成于动荡的沉积环境。

Palaeophycus 遗迹组构密集分布于灰黑色巨厚层介壳灰岩底部,该巨厚层介壳灰岩上下均为发育水平层理的页岩。*Palaeophycus* 平行或略倾斜分布于介壳灰岩底层面上,介壳灰岩代表了水动力较强的环境。下伏与上覆的页岩则是在相对安静的水体中形成。结合遗迹组构分析总体可以做出如下推断,*Palaeophycus* 的造迹生物是在页岩指示的安静水体时期来到了湖底,当时水体溶解氧含量较高、光照充足、有机质含量丰富,生物以水体中垂直沉降的有机质为食,多期次定居留下大量活动痕迹。而后因为沉积环境水动力条件逐渐增强,被动荡环境形成的介壳灰岩所充填,遗迹化石发育的巨厚介壳灰岩之上页岩与介壳灰岩的厚度均明显变薄,指示湖泊萎缩。

综上所述,四川盆地东部地区的湖相沉积环境变化趋势与四川盆地北部地区相一致,区别在于东部地区局部发育有大规模的遗迹化石 *Palaeophycus*,指示局部层段生物活动频繁,沉积环境食物供应充足,氧含量高等特点,更适宜生物生存,并可能存在一定的沉积间断。

表Ⅱ 层面生物扰动指数分级表(引自 Miller and Smail,1997)

Grading chart of bedding-plane bioturbation indices(BPBI)(from Miller and Smail, 1997)

扰动级别	扰动量	描 述
1	0	无扰动。唯一扰动由物理或者化学作用造成(例如干裂特征,盐石膏)。所有原始沉积结构均得以保留。
2	0—10%	0 到 10%扰动。生物扰动显示为较均匀扰动带或形态轮廓明显的遗迹化石。大多数遗迹化石零星分布,但存在局部重叠。
3	10%—40%	10%到 40%扰动。生物扰动以零散遗迹和较均匀的扰动带或二者兼而有之为代表。潜穴一般较为分散,但局部重叠。
4	40%—60%	40%到 60%扰动。生物扰动以零散遗迹、一般扰动或者二者兼而有之为代表。形态轮廓明显的遗迹化石相互交叠现象更加普遍。可识别出扰动程度最大的层理结构,潜穴相互重叠且部分模糊。
5	60%—100%	60%到 100%扰动。层面全部被生物活动所扰动。

4 结 论

1) 在重庆万州区铁峰山下侏罗统自流井组大安寨段中首次发现遗迹化石,该遗迹化石经过对比研究鉴定为古藻迹新种 *Palaeophycus tiefengshanensis* isp. nov.。

2) 该类遗迹化石形成于早侏罗世的特殊湖相沉积背景下,根据沉积相变化特征,四川盆地东部地区自流井组沉积期经历了一次由水体相对较深且较为平静到水体动荡高能环境的转变过程,其变化趋势与四川盆地北部地区类似。新发现遗迹化石产出层位的层面生物扰动指数为最高级,说明四川盆地东部地区自流井组沉积期的局部层段食物供应充足,水体氧含量高,环境更加适宜生物生活和生存。

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A NEW TYPE OF LACUSTRINE ICHNOFOSSILS FROM THE LOWER JURASSIC ZILIUJING FORMATION IN WANZHOU OF CHONGQING AND ITS PALEOENVIRONMENTAL SIGNIFICANCES

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Key words *Palaeophycus tiefengshanensis*, ichnofabric, Ziliujing Formation, Lower Jurassic, Wanzhou

Abstract

The Early Jurassic trace fossil is reported for the first time from the Da'nanzhai Member of the Lower Jurassic Ziliujing Formation in Tiefeng Mountain of Wanzhou, Chongqing. The newly-found trace fossil is attributed to a new ichnospecies-*Palaeophycus tiefengshanensis*, which differs from other ichnospecies of *Palaeophycus* by its large size and nodular surface. Ichnofabric analysis shows that the bedding-plane bioturbation indice of the *Palaeophycus* ichnofabric is 5 representing the highest level of bioturtation, which suggests abundant food supply, high level of oxygen content and frequent animal activities. Based on the sedimentary facies changes of the Tiefengxiang section, the eastern region of Sichuan Basin experienced a similar environmental transformation of lake regression as the northern region of Sichuan Basin; the differences are the locally more habitable environment for ichnofauna in the studied area.

SYSTEMATIC ICHNOLOGY

Ichnogenus *Palaeophycus* Hall, 1847

Type ichospecies *Palaeophycus tubularis* Hall, 1847

Diagnosis Branched or, more typically, unbranched, straight, curved to slightly undulose, smooth or ornamented, lined, predominantly horizontal cylindrical structures of variable diameter; fill typically structureless and similar to the host rock.

Remarks There were about 50 ichnospecies of *Palaeophycus* documented historically (Hall, 1847, James, 1885; Osgood, 1970; Pemberton and Frey, 1982), among which 44 (85%) were described from 1847 to 1883, when fossils of different age and area with slight differences were defined as new ichnospecies, and moreover many of them were incompletely preserved. Pemberton and Frey (1982) reduced the many ichnospecies of *Palaeophycus* to 5, i. e. the distinctly lined, smooth-walled, unornamented burrows including thick-walled *P. heberti* and thin-walled *P. tubularis*, as well as very thinly lined, longitudinally striated burrows enveloping *P. striatus* with continuous parallel striae, *P. sulcatus* with irregular anastomosing striae, and alternately striate and annulate *P. ternatus*.

Palaeophycus tiefengshanensis isp. nov.

(Text-fig. 3)

Etymology Specific epithet is after Tiefengshan in Wanzhou, the type locality is subject regionally.

Type specimen Holotype specimen no. WZHS1 (housed in Chongqing 208 Geoheritage Protection and Research Institute)

Diagnosis Horizontal burrows, slightly or irregularly curved, with large burrow diameter

(6-8 cm). Burrow surface covered with small nodules and common bivalve shells. Passively filled and filling identical to the host rock in composition.

Description Horizontal burrows, slightly or irregularly curved, mostly parallel or slightly inclined to bedding, densely distributed, burrows usually cross-cut or superimpose with each other, Common preserved length over 10 cm, occasionally up to 1 m, burrow diameter 6-8 cm. Burrow surface covered with numerous small nodules, and usually with bivalve shells. The tubes are, elliptical in cross section, probably because of compaction, with the long axes varying between 5-8 cm and short axes between 2-3 cm, which could be separated from the host rock, leaving a canal. Thus the trace fossil is preserved as full reliefs on the lower bedding surface. Burrow filling is made of shelly limestone, which is identical to the host rock.

Table 1　Comparison of characteristics between *P. tiefengshanensis* and published ichnospecies of *Palaeophycus*

Ichnospecies	References	Description	Diameter (mm)	Length (mm)	Age
P. sulcatus	(Raghavendra *et al.*, 2011)	Burrows with irregular branch striae	12	150	Miocene
P. alternatus	(Zhang *et al.*, 2011)	Burrows with crossed cross and thin striae	3-5	<100	Early Devonian
P. tubularis	(Wang *et al.*, 2004)	Smooth-and thin-walled	2-10	12-90	early Cambrian, Late Ordovician
P. striatus	(Wang *et al.*, 2004)	Burrows with continuously parallel striae	5-10	70-80	Early Devonian
P. heberti	(Wang *et al.*, 2004)	Smooth-and thick-walled	4	50	Early Ordovician
Palaeophycus isp.	(Wang *et al.*, 2004)	Smooth-walled	4-5	80	Early Devonian
Palaeophycus isp.	(Wang *et al.*, 2004)	Smooth-walled	2-4	20-60	Early Cambrian
P. wutingensis	(Wang *et al.*, 2004)	Burrow with irregular, inclined striae and local burrow swelling	3-10	50	Early Ordovician
P. bolbitermilus	(Kim *et al.*, 2001)	Burrow with a bulb-like termination	3-12	4-21	Llandovery, Silurian
Palaeophycus isp.	(Chrząstek, 2013)	Smooth-walled, with lining	2-9	3.5-4.7	Middle Triassic
Palaeophycus isp.	(Weber *et al.*, 2012)	Smooth-walled, with lining	1-2	5-20	Cambrian
P. tiefengshanensis isp. nov.	This paper	Nodular burrow surface without striae, commonly covered with bivalve shells	55-80	100-1000	Early Jurassic

Comparison There are many reports about *Palaeophycus* in the literature. In this paper, we summarize the morphological features (mainly burrow wall characteristics) and sizes of some of the available reports of *Palaeophycus*.

The table shows that the newly-found trace fossil in Wanzhou is different from published *Palaeophycus* by its great burrow diameter and length, as well as by its nodular and/or shelly burrow surface. It contrasts to *P. tubularis*, *P. heberti* with smooth surfaces, to *P. striatus*, *P. sulcatus*, *P. alternatus* with various types of striae, and to *P. wutingensis* that has an irregular striate surface and local burrow swelling.

Kim *et al.* (2001) proposed a new ichnospecies-*Palaeophycus bolbitermilus* when studying the trace fossils from the lower Silurian Upsalquitch Formation from New Brunswick, Canada. It is characterized by a terminal bulb which makes *P. bolbitermilus* different from the

studied trace fossil here.

In conclusion, the studied trace fossil in this paper is a new type from Tiefengshan of Wanzhou and is assigned to *Palaeophycus tiefengshanensis*.

At present the trace maker of this exceptionally large *Palaeophycus* could not be confirmed, yet it is certain that *P. tiefengshanensis* was made by some large animals, much bigger than the trace makers of previous records.

Locality and horizon Tiefengshan in Wanzhou, Chongqing; Da'nanzhai Member, Ziliujing Formation (Lower Jurassic).