



中国地质大学
China University of Geosciences

国际年代地层与金钉子

童金南

(地球科学学院)

地球历史阶段的划分

隐生宙

显生宙

3400 最初生命遗迹

前寒武纪

540

寒武纪

500

奥陶纪

435

志留纪

410

泥盆纪

355

石炭纪

295

二叠纪

252

三叠纪

203

侏罗纪

142

白垩纪

66

第三纪

1.8

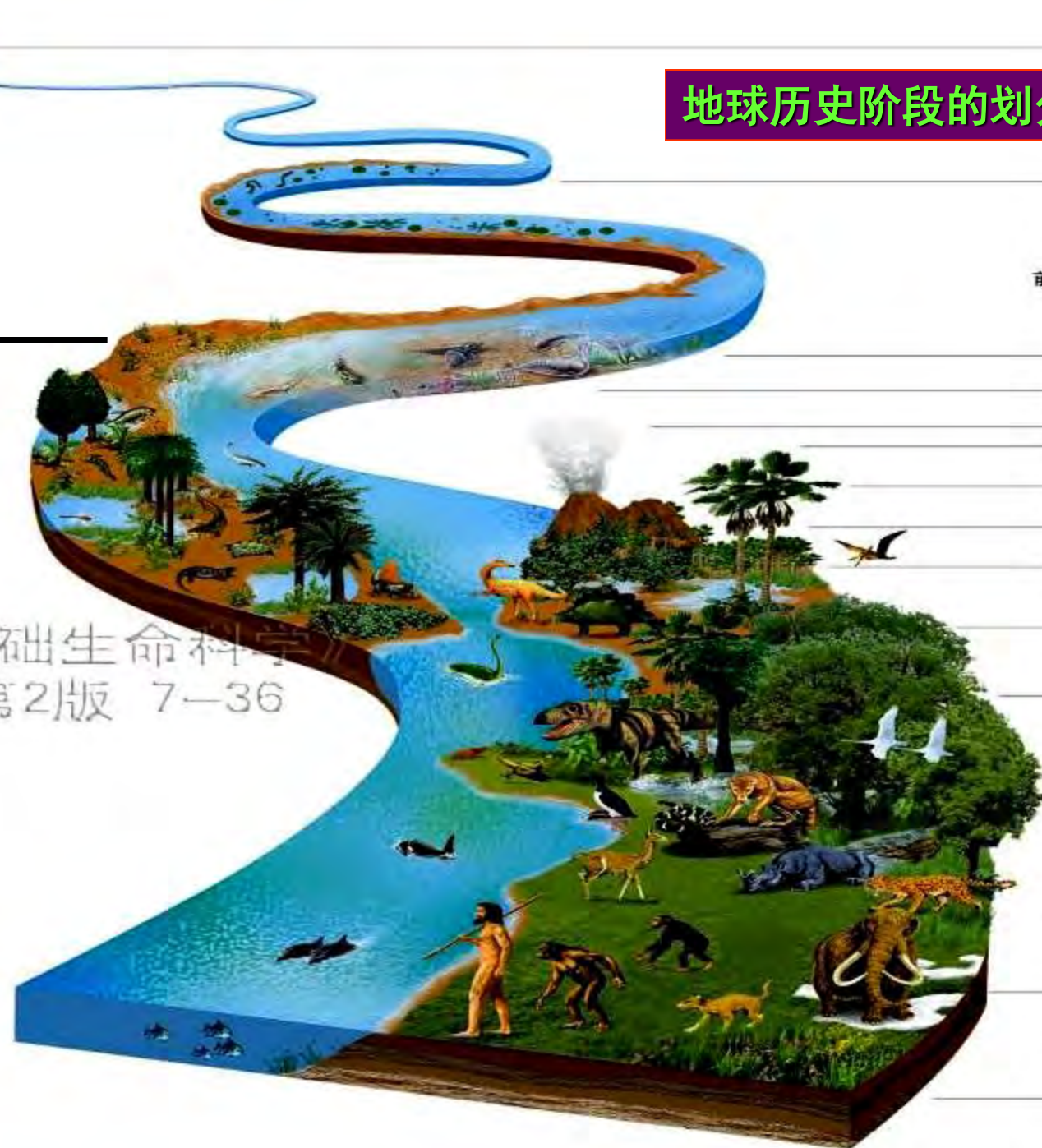
第四纪

古生代

中生代

新生代

《基础生命科学》
第2版 7-36



INTERNATIONAL STRATIGRAPHIC CHART

International Union of Geological Sciences

Compiled by Jürgen Retzsch, Chairman of the International Commission of Stratigraphy (ICS) with the collaboration of all ICS Subcommissions A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z, AA, AB, AC, AD, AE, AF, AG, AH, AI, AJ, AK, AL, AM, AN, AO, AP, AQ, AR, AS, AT, AU, AV, AW, AX, AY, AZ, BA, BB, BC, BD, BE, BF, BG, BH, BI, BJ, BK, BL, BM, BN, BO, BP, BQ, BR, BS, BT, BU, BV, BW, BX, BY, BZ, CA, CB, CC, CD, CE, CF, CG, CH, CI, CJ, CK, CL, CM, CN, CO, CP, CQ, CR, CS, CT, CU, CV, CW, CX, CY, CZ, DA, DB, DC, DD, DE, DF, DG, DH, DI, DJ, DK, DL, DM, DN, DO, DP, DQ, DR, DS, DT, DU, DV, DW, DX, DY, DZ, EA, EB, EC, ED, EE, EF, EG, EH, EI, EJ, EK, EL, EM, EN, EO, EP, EQ, ER, ES, ET, EU, EV, EW, EX, EY, EZ, FA, FB, FC, FD, FE, FF, FG, FH, FI, FJ, FK, FL, FM, FN, FO, FP, FQ, FR, FS, FT, FU, FV, FW, FX, FY, FZ, GA, GB, GC, GD, GE, GF, GG, GH, GI, GJ, GK, GL, GM, GN, GO, GP, GQ, GR, GS, GT, GU, GV, GW, GX, GY, GZ, HA, HB, HC, HD, HE, HF, HG, HH, HI, HJ, HK, HL, HM, HN, HO, HP, HQ, HR, HS, HT, HU, HV, HW, HX, HY, HZ, IA, IB, IC, ID, IE, IF, IG, IH, II, IJ, IK, IL, IM, IN, IO, IP, IQ, IR, IS, IT, IU, IV, IW, IX, IY, IZ, JA, JB, JC, JD, JE, JF, JG, JH, JI, JJ, JK, JL, JM, JN, JO, JP, JQ, JR, JS, JT, JU, JV, JW, JX, JY, JZ, KA, KB, KC, KD, KE, KF, KG, KH, KI, KJ, KK, KL, KM, KN, KO, KP, KQ, KR, KS, KT, KU, KV, KW, KX, KY, KZ, LA, LB, LC, LD, LE, LF, LG, LH, LI, LJ, LK, LL, LM, LN, LO, LP, LQ, LR, LS, LT, LU, LV, LW, LX, LY, LZ, MA, MB, MC, MD, ME, MF, MG, MH, MI, MJ, MK, ML, MM, MN, MO, MP, MQ, MR, MS, MT, MU, MV, MW, MX, MY, MZ, NA, NB, NC, ND, NE, NF, NG, NH, NI, NJ, NK, NL, NM, NN, NO, NP, NQ, NR, NS, NT, NU, NV, NW, NX, NY, NZ, OA, OB, OC, OD, OE, OF, OG, OH, OI, OJ, OK, OL, OM, ON, OO, OP, OQ, OR, OS, OT, OU, OV, OW, OX, OY, OZ, PA, PB, PC, PD, PE, PF, PG, PH, PI, PJ, PK, PL, PM, PN, PO, PP, PQ, PR, PS, PT, PU, PV, PW, PX, PY, PZ, QA, QB, QC, QD, QE, QF, QG, QH, QI, QJ, QK, QL, QM, QN, QO, QP, QQ, QR, QS, QT, QU, QV, QW, QX, QY, QZ, RA, RB, RC, RD, RE, RF, RG, RH, RI, RJ, RK, RL, RM, RN, RO, RP, RQ, RR, RS, RT, RU, RV, RW, RX, RY, RZ, SA, SB, SC, SD, SE, SF, SG, SH, SI, SJ, SK, SL, SM, SN, SO, SP, SQ, SR, SS, ST, SU, SV, SW, SX, SY, SZ, TA, TB, TC, TD, TE, TF, TG, TH, TI, TJ, TK, TL, TM, TN, TO, TP, TQ, TR, TS, TT, TU, TV, TW, TX, TY, TZ, UA, UB, UC, UD, UE, UF, UG, UH, UI, UJ, UK, UL, UM, UN, UO, UP, UQ, UR, US, UT, UV, UW, UX, UY, UZ, VA, VB, VC, VD, VE, VF, VG, VH, VI, VJ, VK, VL, VM, VN, VO, VP, VQ, VR, VS, VT, VU, VV, VW, VX, VY, VZ, WA, WB, WC, WD, WE, WF, WG, WH, WI, WJ, WK, WL, WM, WN, WO, WP, WQ, WR, WS, WT, WU, WV, WW, WX, WY, WZ, XA, XB, XC, XD, XE, XF, XG, XH, XI, XJ, XK, XL, XM, XN, XO, XP, XQ, XR, XS, XT, XU, XV, XW, XX, XY, XZ, YA, YB, YC, YD, YE, YF, YG, YH, YI, YJ, YK, YL, YM, YN, YO, YP, YQ, YR, YS, YT, YU, YV, YW, YX, YY, YZ, ZA, ZB, ZC, ZD, ZE, ZF, ZG, ZH, ZI, ZJ, ZK, ZL, ZM, ZN, ZO, ZP, ZQ, ZR, ZS, ZT, ZU, ZV, ZW, ZX, ZY, ZZ



Commission de la Carte Géologique du Monde
Commission on the Geological Map of the World



eonothem	era	system	series	stage	age	Ma	stage notation	series notation	system notation
Phanerozoic	Erathean	Cenozoic	Holocene			0.01		Q ₁	Q
			Pleistocene	Calabrian	1.83		Q ₂	Q	
Phanerozoic	Erathean	Cenozoic	Miocene	Santallian	11.2			N ₁	
				Lanthisian	14.8		N ₂		
				Burdigalian	16.4		N ₃		
Phanerozoic	Erathean	Cenozoic			26.5				
					28.2				
					28.5				

Global Stratotype Section and Point - GSSP

Global Standard Stratigraphical Age - GSSA

eonothem	era	system	series	stage	age	Ma	stage notation	series notation	system notation		
Phanerozoic	Erathean	Cenozoic	Neogene								
		Cenozoic	Erathean	Neogene	Quaternary						

eonothem	era	system	series	stage	age	Ma	stage notation	series notation	system notation		
Phanerozoic	Erathean	Cenozoic	Neogene								
		Cenozoic	Erathean	Neogene	Quaternary						

International Commission on Stratigraphy

eonothem	era	system	series	stage	age	Ma	stage notation	series notation	system notation		
Phanerozoic	Erathean	Cenozoic	Neogene								
		Cenozoic	Erathean	Neogene	Quaternary						

This 2000 edition of the International Stratigraphic Chart is intended to give a clear picture of the present

GSSP (“金钉子”) 即国际年代地层单位分界的标准

periodically during its general assemblies occurring within the International Geological Congress and upon ratification of GSSPs by IUGS.

Status of GSSPs in January 2002 (updated by James Ogg)



Eonothem / Eon Erathem / Era System / Period		Series / Epoch	Stage / Age	GSSP	numerical age (Ma)	
Phanerozoic	Cenozoic	Quaternary	Holocene		0.0117	
			Upper Pleistocene		0.126	
			Middle Pleistocene		0.781	
		Pliocene	Calabrian		1.80	
			Gelasian		2.58	
			Piacenzian		3.600	
		Neogene	Miocene	Zanclean		5.333
				Messinian		7.246
				Tortonian		11.63
			Oligocene	Serravallian		13.82
	Langhian				15.97	
	Burdigalian				20.44	
	Aquitanian				23.03	
	Paleogene	Eocene	Chatian		26.1	
			Rupelian		33.9	
		Oligocene	Priabonian		37.8	
			Bantonian		41.2	
			Lutetian		47.8	
		Paleocene	Ypresian		56.0	
			Thanetian		59.2	
Selandian				61.6		
Danian				66.0		
Maastrichtian				72.1 ± 0.2		
Mesozoic	Cretaceous	Campanian		83.6 ± 0.2		
		Santonian		86.3 ± 0.5		
		Coniacian		89.8 ± 0.3		
		Turonian		93.9		
		Cenomanian		100.5		
	Lower	Albian		~ 113.0		
		Aptian		~ 125.0		
		Barremian		~ 129.4		
		Hauterivian		~ 132.9		
		Valanginian		~ 139.6		
Bemianian		~ 145.0				

Eonothem / Eon Erathem / Era System / Period		Series / Epoch	Stage / Age	GSSP	numerical age (Ma)
Phanerozoic	Mesozoic	Jurassic	Tithonian		152.1 ± 0.9
			Upper Kimmeridgian		157.3 ± 1.0
			Oxfordian		163.5 ± 1.0
		Middle	Callovian		165.1 ± 1.2
			Bathonian		168.3 ± 1.3
			Bajocian		170.3 ± 1.4
		Lower	Aalenian		174.1 ± 1.0
			Toarcian		182.7 ± 0.7
			Phliensbachian		190.8 ± 1.0
			Sinemurian		199.3 ± 0.3
	Hettangian		201.3 ± 0.2		
	Rhaetian		~ 208.5		
	Triassic	Upper	Norian		~ 227
			Garnian		~ 237
		Lower	Laomian		~ 242
			Anisian		247.2 ± 0.06
			Olenekian		251.2 ± 0.07
	Permian	Lopingian	Changhsingian		252.17 ± 0.06
			Wuchiapingian		254.14 ± 0.07
			Capitanian		259.9 ± 0.4
Guadalupian		Wordian		265.1 ± 0.4	
		Roadian		268.8 ± 0.5	
Cisuralian		Kungurian		272.3 ± 0.5	
		Artinskian		283.5 ± 0.6	
		Sakmarian		290.1 ± 0.26	
		Asselian		295.0 ± 0.18	
		Gzhelian		298.9 ± 0.15	
Carboniferous	Pennsylvanian	Upper Gzhelian		303.7 ± 0.1	
		Middle Kasimovian		307.0 ± 0.1	
		Lower Moscovian		315.2 ± 0.2	
	Mississippian	Upper Bashkirian		323.2 ± 0.4	
		Serpukhovian		330.9 ± 0.2	
Visean		346.7 ± 0.4			
Tournaisian		358.9 ± 0.4			

Eonothem / Eon Erathem / Era System / Period		Series / Epoch	Stage / Age	GSSP	numerical age (Ma)
Phanerozoic	Paleozoic	Devonian	Upper Famennian		372.2 ± 1.6
			Frasnian		382.7 ± 1.6
			Givetian		387.7 ± 0.8
			Eifelian		393.3 ± 1.2
			Emsian		407.6 ± 2.6
		Silurian	Lower Pragian		410.8 ± 2.8
			Lochkovian		419.2 ± 3.2
			Pridoli		423.0 ± 2.3
			Ludlow Ludfordian		425.6 ± 0.9
			Gorstian		427.4 ± 0.5
	Ordovician	Wenlock Homerian		430.5 ± 0.7	
		Sheinwoodian		433.4 ± 0.8	
		Telychian		438.5 ± 1.1	
		Aeronian		440.8 ± 1.2	
		Rhuddanian		443.8 ± 1.5	
	Cambrian	Upper Himantian		445.2 ± 1.4	
		Katian		453.0 ± 0.7	
		Sandbian		458.4 ± 0.9	
		Darriwilian		467.3 ± 1.1	
		Dapingian		470.0 ± 1.4	
Precambrian	Proterozoic	Lower Floian		477.7 ± 1.4	
		Tremadocian		485.4 ± 1.9	
		Furongian		~ 489.5	
		Jiangshanian		~ 494	
		Paibian		~ 497	
	Archean	Series 3		~ 500.5	
		Drumian		~ 504.5	
		Series 5		~ 509	
		Series 4		~ 514	
		Series 3		~ 521	
Terreneuvian		~ 529			
Fortunian		541.0 ± 1.0			

Eonothem / Eon	Erathem / Era	System / Period	GSSP	numerical age (Ma)
Precambrian	Proterozoic	Ediacaran		~ 541.0 ± 1.0
		Cryogenian		~ 635
		Tonian		850
		Stenian		1000
		Ectasian		1200
	Mesoproterozoic	Calymnian		1400
		Statherian		1600
		Orosinian		1800
		Rhyacian		2050
		Siderian		2300
	Paleoproterozoic	Neoarchean		2500
		Mesoarchean		2600
		Paleoarchean		3200
		Euarchean		3600
		Hadean		~ 4600

Units of all ranks are in the process of being defined by Global Boundary Stratotype Section and Points (GSSP) for their lower boundaries, including those of the Archean and Proterozoic, long defined by Global Standard Stratigraphic Ages (GSSA). Charts and detailed information on ratified GSSPs or without constrained numerical ages, an approximate numerical age (~) is provided.

Numerical ages are subject to revision and do not define units in the Phanerozoic and the Ediacaran; only GSSPs do. For boundaries in the Phanerozoic without ratified GSSPs or without constrained numerical ages, an approximate numerical age (~) is provided.

Numerical ages for all systems except lower Pleistocene, Permian, Triassic, Cretaceous and Precambrian are taken from 'The Geologic Time Scale 2012' by Gradstein et al. (2012). Those for the lower Pleistocene, Permian, Triassic and Cretaceous were provided by the relevant ICS subcommissions.

Coloring followed by the Commission for the Geological Map of the World (<http://www.cgmw.org>)

Chart drafted by K.M. Cohen, S.C. Finney, P.L. Gibbard (c) International Commission on Stratigraphy, October 2014

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URL: <http://www.stratigraphy.org/ICSChart/ChronostratChart2014-10.pdf>





国际地层表 v 2013/01

国际地层委员会

www.stratigraphy.org



宇界系 (宙/代/纪)	统 (世)	阶 (期)	GSSP	年龄 (Ma) 距今	
第四系	全新统			0.0117	
	更新统	更新统上阶		0.126	
		更新统中阶		0.781	
	上新统	卡拉布里雅阶		1.806	
		杰拉阶		2.588	
	新近系	中新统	皮亚琴察阶		3.600
			赞克尔阶		5.333
		渐新统	墨西哥阶		7.246
			托尔托纳阶		11.62
			塞拉瓦莱阶		13.62
兰盖阶				15.97	
波尔多阶				20.44	
阿眉坦阶				23.03	
卡塞尔阶				28.1	
吕珀尔阶				33.9	
古近系	始新统	普利亚本阶		38.0	
		巴顿阶		41.3	
	古新统	卢泰特阶		47.8	
		伊普里斯阶		56.0	
		坦尼特阶		59.2	
		塞兰特阶		61.6	
		丹麦阶		66.0	
		马斯特里赫特阶		72.1 ± 0.2	
		上白垩统	坎潘阶		83.6 ± 0.2
			圣通阶		86.3 ± 0.5
康尼亚克阶			89.8 ± 0.3		
土伦阶			93.9		
塞诺曼阶			100.5		
阿尔布阶	阿尔布阶		~113.0		
	阿普特阶		~125.0		
	巴雷姆阶		~129.4		
	欧特里夫阶		~132.9		
	凡兰今阶		~139.8		
	贝里阿斯阶		~145.0		

宇界系 (宙/代/纪)	统 (世)	阶 (期)	GSSP	年龄 (Ma) 距今
侏罗系	上侏罗统	提塘阶		145.0 ± 0.8
		钦莫里阶		152.1 ± 0.9
	中侏罗统	牛津阶		157.3 ± 1.0
		牛津阶		163.5 ± 1.0
		卡洛夫阶		166.1 ± 1.2
		巴柔阶		168.3 ± 1.3
		阿林阶		170.3 ± 1.4
		托阿尔阶		174.1 ± 1.0
	下侏罗统	普林斯巴赫阶		182.7 ± 0.7
		辛涅缪尔阶		190.8 ± 1.0
三叠系	上三叠统	赫姆阶		~208.5
		瑞替阶		~208.5
	中三叠统	诺利阶		~227
		卡尼阶		~227
	下三叠统	拉丁阶		~237
		安尼阶		~242
	乐平统	奥伦尼克阶		247.2
		印度阶		251.2
		长兴阶		252.17 ± 0.06
		吴家坪阶		254.14 ± 0.07
卡匹敦阶			259.8 ± 0.4	
沃德阶			265.1 ± 0.4	
罗德阶			268.8 ± 0.5	
空谷阶			272.3 ± 0.5	
瓜德鲁普统	亚丁斯克阶		283.5 ± 0.5	
	萨克马尔阶		290.1 ± 0.26	
	阿瑟尔阶		295.5 ± 0.18	
	格舍尔阶		298.9 ± 0.15	
	卡西莫夫阶		303.7 ± 0.1	
	莫斯科阶		307.0 ± 0.1	
乌拉尔统	巴什基尔阶		315.2 ± 0.2	
	谢尔普霍夫阶		323.2 ± 0.4	
	维米阶		330.9 ± 0.2	
	杜内阶		346.7 ± 0.4	
	共余尼亚系		358.9 ± 0.4	
	密西西比亚系		358.9 ± 0.4	

宇界系 (宙/代/纪)	统 (世)	阶 (期)	GSSP	年龄 (Ma) 距今	
泥盆系	上泥盆统	法门阶		358.9 ± 0.4	
		弗拉阶		372.2 ± 1.6	
	中泥盆统	吉维特阶		382.7 ± 1.6	
		艾菲尔阶		387.7 ± 0.8	
		埃姆斯阶		393.3 ± 1.2	
		布拉格阶		407.6 ± 2.6	
	下泥盆统	洛赫考夫阶		410.8 ± 2.6	
		普里道利统		419.2 ± 3.2	
	志留系	罗德洛统	卢德福特阶		423.0 ± 2.3
		温洛克统	高斯特阶		425.6 ± 0.9
侯堡阶				427.4 ± 0.5	
兰多维列统		申伍德阶		430.5 ± 0.7	
		特别奇阶		433.4 ± 0.6	
奥陶统		埃隆阶		438.5 ± 1.1	
	鲁丹阶		440.8 ± 1.2		
	赫南特阶		443.4 ± 1.5		
	凯迪阶		445.2 ± 1.4		
	桑比阶		453.0 ± 0.7		
	桑比阶		458.4 ± 0.9		
中奥陶统	达瑞威尔阶		467.3 ± 1.1		
	大坪阶		470.0 ± 1.4		
	弗洛阶		477.7 ± 1.4		
	特马豆克阶		485.4 ± 1.9		
寒武系	芙蓉统	第十阶		~489.5	
	第三统	江山阶		~494	
		排碧阶		~497	
	第五阶	古丈阶		~500.5	
		鼓山阶		~504.5	
	第四阶	第四阶		~509	
第三阶			~514		
第二阶	第二阶		~521		
	第二阶		~529		
纽芬兰统	幸运阶		541.0 ± 1.0		

宇界系 (宙/代/纪)	统 (世)	阶 (期)	GSSP	年龄 (Ma) 距今
元古宙	新元古界	埃迪卡拉系		~541
		成冰系		~635
	中元古界	拉伸系		850
		狭带系		1000
		延展系		1200
		盖层系		1400
	古元古界	固结系		1600
		造山系		1800
	新太古界	层侵系		2050
		成铁系		2300
中太古界			2500	
古太古界			2800	
始太古界	始太古界		3200	
	始太古界		3600	
前寒武系	始太古界		4000	
	始太古界		~4600	

每一个全球年代地层单位都是通过其底部的全球界线层型剖面和层型点 (GSSP) 界定。元古宙和太古宙地层单位通过全球标准地质年龄 (GSSA) 界定。每个GSSP的详情公布在国际地层委员会的网站上。
<http://www.stratigraphy.org>
 元古宙中未正式批准GSSP和未确定年龄值的单位，在前寒武系中唯一由GSSP界定的埃迪卡拉系的年龄值还有待修订。其年龄值用近似年龄值表示 (~)。
 除三叠系、白垩系和前寒武系外，所有年龄值均引自Gradstein等的《地质年代表2012》，三叠系和白垩系的年龄值由三叠系、白垩系分会提供。
 地层单位的颜色是参照世界地质图委员会的色谱。
<http://www.cgm.org>

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 K.M. Cohen, S. Finney, P.L. Gibbard 等译。



“金钉子”

——“全球年代地层界线层型剖面点”（GSSP）的简称

- 地质时间划分的国际标准（时间标竿）
- 地质历史时期的格林威治时间标准
- 全球唯一点位



满足“金钉子”的条件：

- **科学性**——客观地质历史阶段标志
- **权威性**——全球唯一、世人公认和遵循
- **先进性**——研究最好的范例

四轮国际投票确定：

- 国际界线工作委员会
- 国际地层委员会断代分会
- 国际地层委员会
- 国际地质科学联合会



我国当前已获得的10个“金钉子”

系	阶名	层型地点	获得时间
三叠系	印度阶	浙江长兴	2001
二叠系	长兴阶	浙江长兴	2005
二叠系	吴家坪阶	广西来宾	2004
石炭系	维宪阶	广西桂林	2008
奥陶系	赫南特阶	湖北宜昌	2006
奥陶系	达瑞威尔阶	浙江长山	1987
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寒武系	江山阶	浙江江山	2011
寒武系	排碧阶	湖南花垣	2003
寒武系	古丈阶	湖南古丈	2008



我国当前已获得的10个“金钉子”

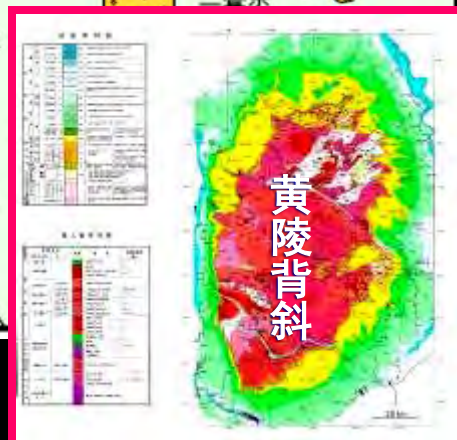
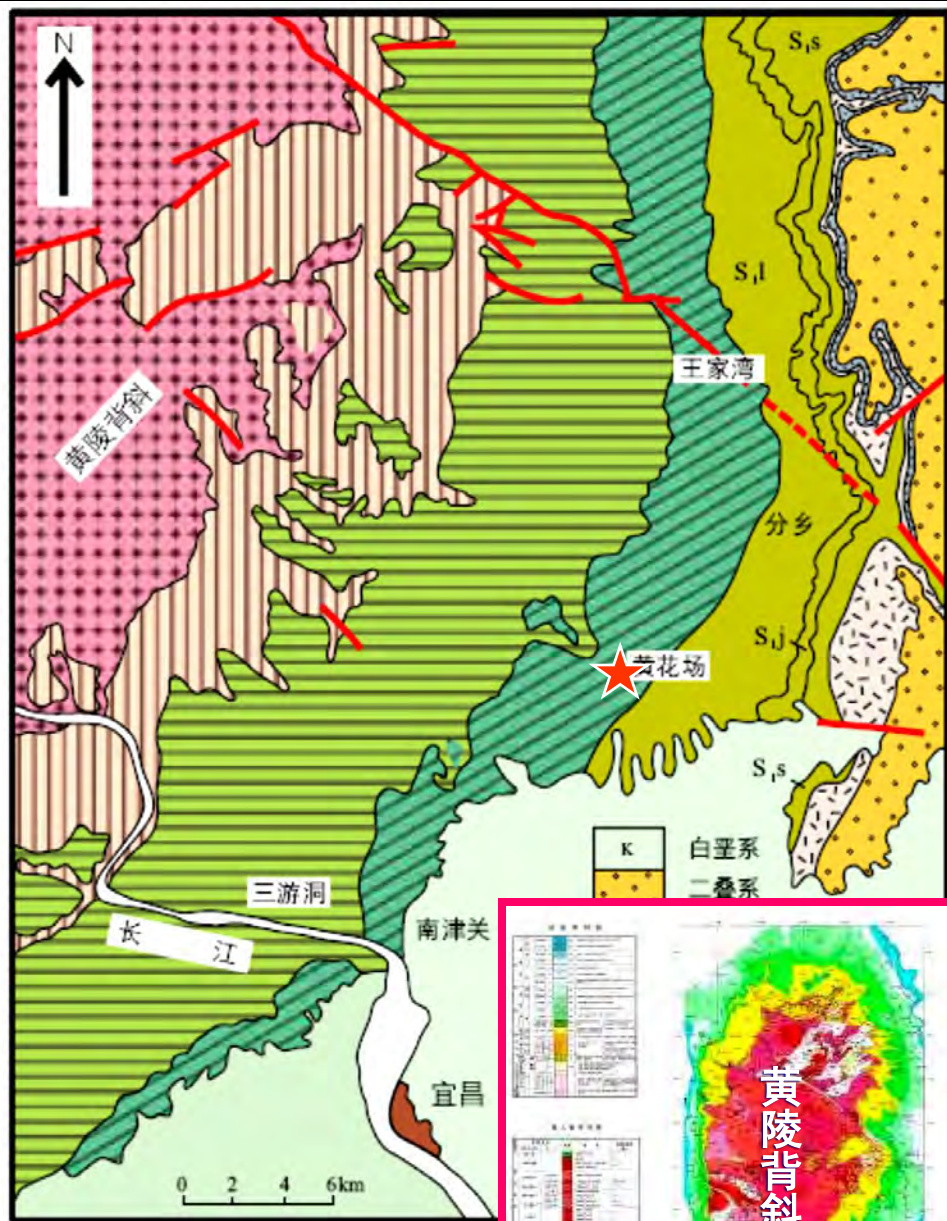
系	阶名	层型地点	获得时间
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寒武系	古丈阶	湖南古丈	2008

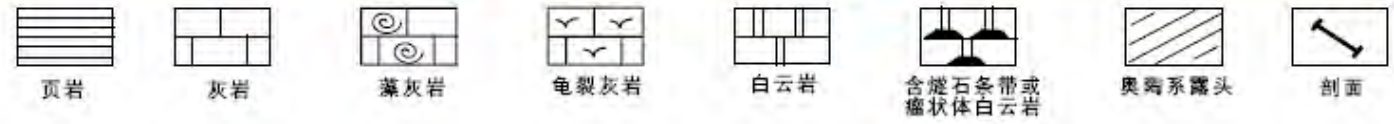
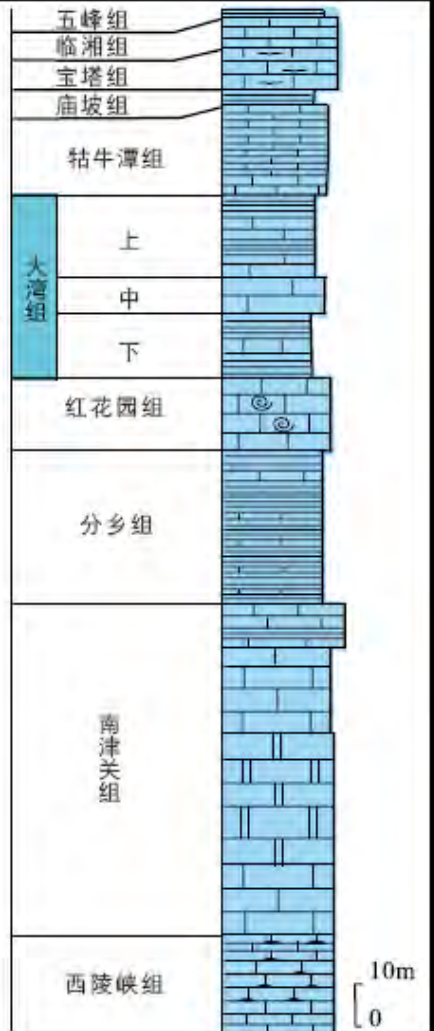
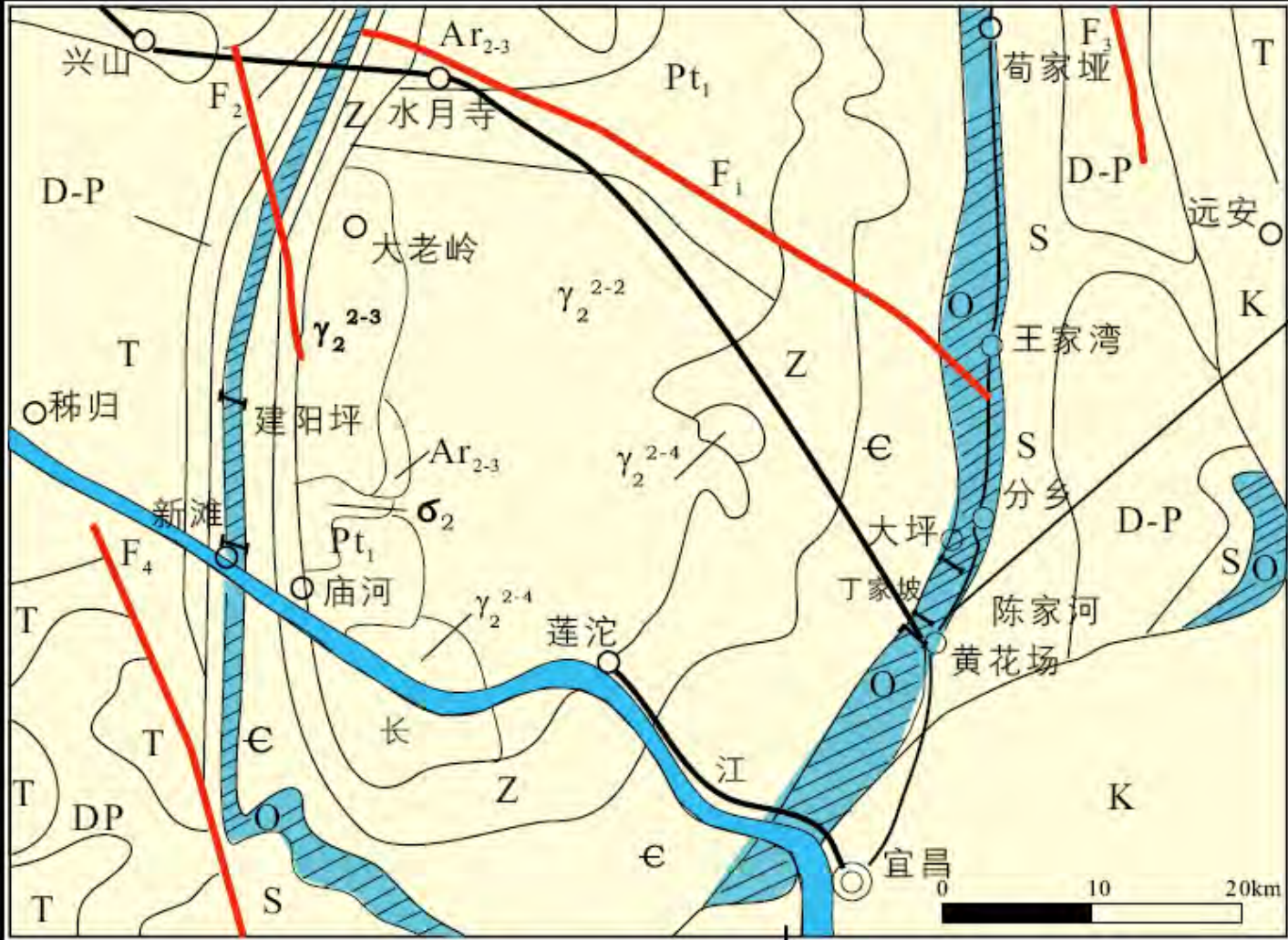


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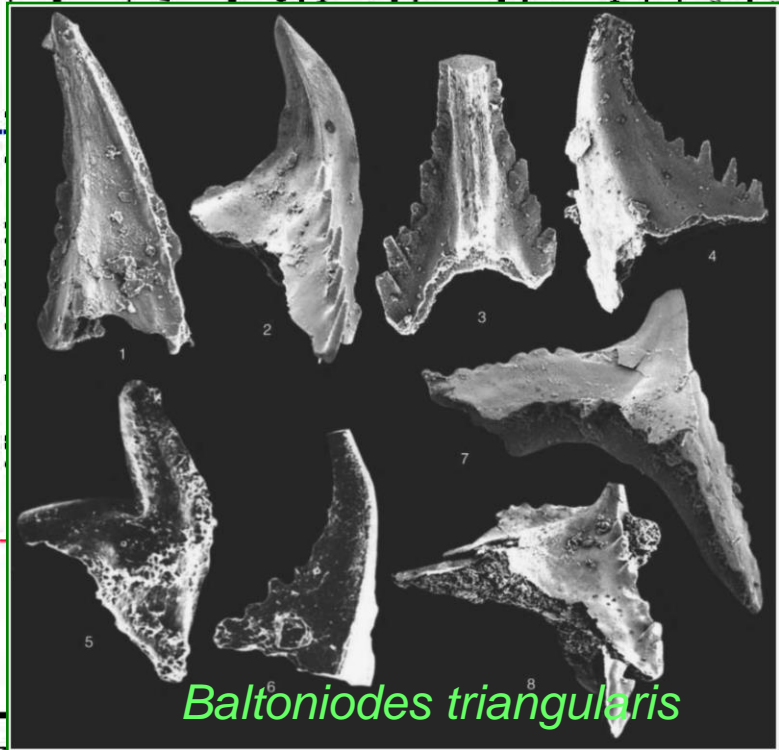
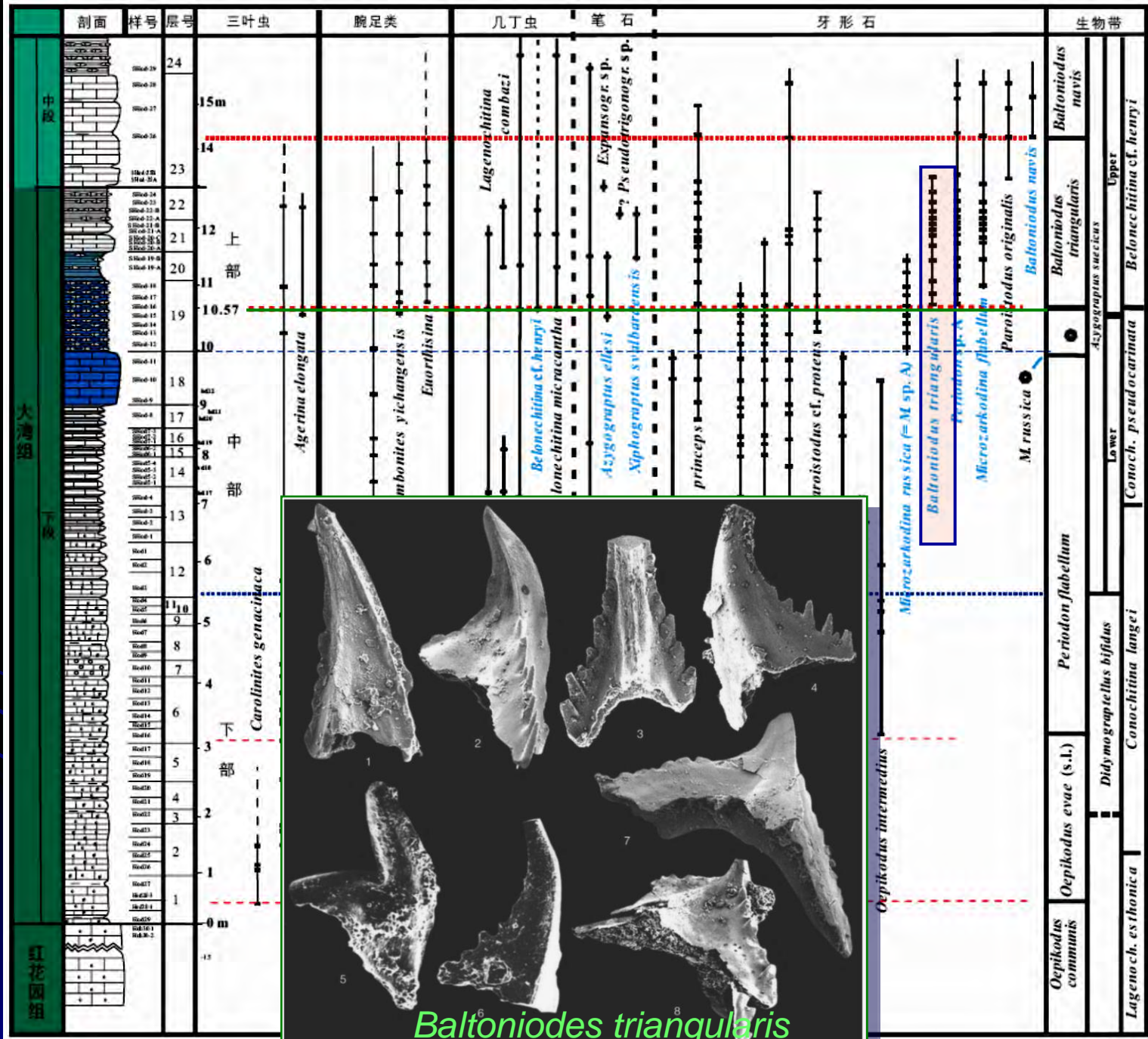
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绝对年龄 (Ma)	国际标准			重要笔石带 和牙形刺带 (c) *弃用的生物带
	系	统	阶	
志留系				
443.4	奥陶系	上奥陶统	赫南特阶 (Himantian)	<i>A. ascensus</i> (GSSP: Dob's Linn) <i>N. extraordinarius</i> (GSSP: 王家湾北剖面)
445.2			凯迪阶 (Katian)	<i>D. complanatus</i> * <i>A. ordovicicus</i> *(c)
453.0			桑比阶 (Sandbian)	<i>D. caudatus</i> (GSSP: Black Knob Ridge)
458.4			达瑞威尔阶 (Darriwilian)	<i>N. gracilis</i> (GSSP: Fagelsang)
467.3	中奥陶统	大坪阶 (Dapingian)	<i>U. austrodentatus</i> (GSSP: 黄泥塘剖面) <i>B. triangularis</i> (c) (GSSP: 黄花场剖面)	
470.0		弗洛阶 (Floian)	<i>T. approximatus</i> (GSSP: Diabasbrottet)	
477.7	下奥陶统	特马豆克阶 (Tremadocian)	<i>I. fluctivagus</i> (c) (GSSP: Green Point)	
485.4				







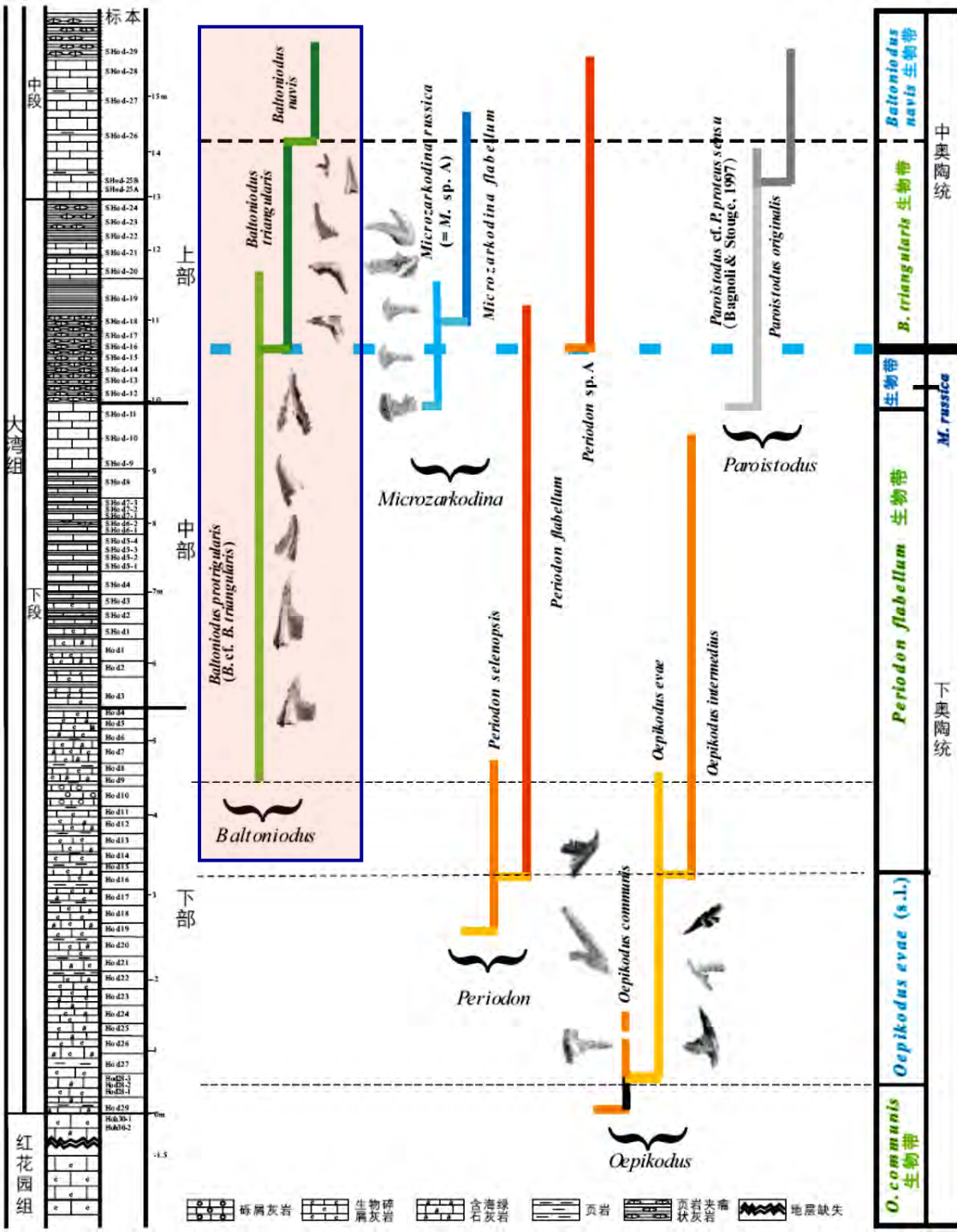


Baltoniodes triangularis





中国地质大学
China University of Geosciences





中国南方				西北欧		加拿大纽芬兰	北美	澳大利亚		
黄花场剖面			江南斜坡	波罗的海斯堪的纳维亚	英国					
组	段	笔石	牙形石							
		Wang et al., 2005, 2009a	本文	Chen et al., 2009; Zhang & Chen, 2003	Cooper et al., 1995; Maletz, 2005		William & Stevens, 1998	Funney & Edington, 1992	Webby & Nicoll, 1989	
中奥陶统	大漕组	中段		<i>Baltoniodus navis</i>		<i>Isograptus</i> sp. nov. 2 & <i>Maeandrogr. schmalens eei</i>	<i>Isograptus gibberulus</i>	<i>Isograptus v. maximus</i>	Ch3 <i>Isograptus v. maximus</i>	
					<i>Baltoniodus triangularis</i>	<i>Isograptus caduceus imitatus</i>	<i>Isograptus v. victoriae</i>	<i>Isograptus v. victoriae</i>	<i>Isograptus v. victoriae</i>	Ch2 <i>Isograptus v. victoriae</i>
	下奥陶统	下段	Azygograptus suecicus	上部	<i>Microzako-dina russica</i>					
下部				<i>Periodon flabellum</i>	<i>Azygograptus suecicus</i>	<i>Pseudophyllogr. angus trifolius elongatus</i>	<i>D. (s.l.) simulans</i>	<i>Isograptus v. lunatus</i>	<i>Isograptus v. lunatus</i>	Ch1 <i>Isograptus v. lunatus</i>
Didymogr. bifidus				<i>C. deflexus</i>		<i>Pseudophyllogr. densus</i>		<i>Didymogr. bifidus</i>	<i>Didymogr. bifidus</i>	Ch2 <i>L. primulus</i>
				<i>Oepikodus evae (s.l.)</i>	<i>D. "protobifidus"</i>		<i>D. (s.l.) varicosus</i>			Ch1 <i>D. "protobifidus"</i>
无笔石				<i>Oepikodus communis</i>	<i>P. fruticosus</i>	<i>D. (s.l.) balticus</i>		<i>P. fruticosus</i>	<i>P. fruticosus</i>	Be 1-4 <i>P. fruticosus</i>
					<i>approximatus</i>			<i>T. akzharensis</i>	<i>T. akzharensis</i>	
红花园组						<i>approximatus</i>	<i>Phyllograptoides</i>	<i>Phyllograptoides</i>	<i>T. approximatus</i>	La3 <i>T. approximatus</i>



GSSP

25



长阳白氏坪

大湾组

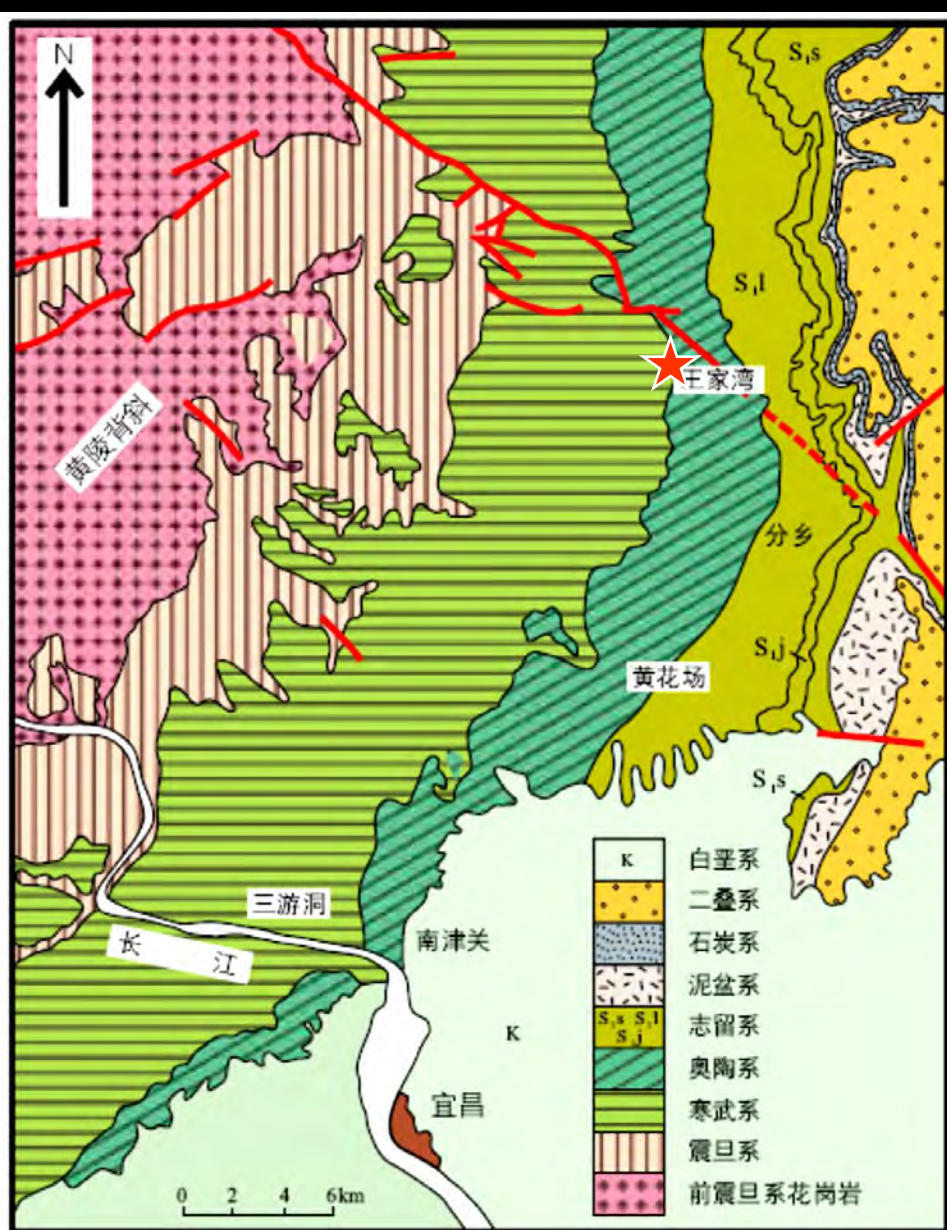




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445.2			凯迪阶 (Katian)	<i>D. complanatus</i> * <i>A. ordovicicus</i> *(c)
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470.0	下奥陶统	弗洛阶 (Floian)	<i>T. approximatus</i> (GSSP: Diabasbrottet)	
477.7		特马豆克阶 (Tremadocian)	<i>I. fluctivagus</i> (c) (GSSP: Green Point)	
485.4				



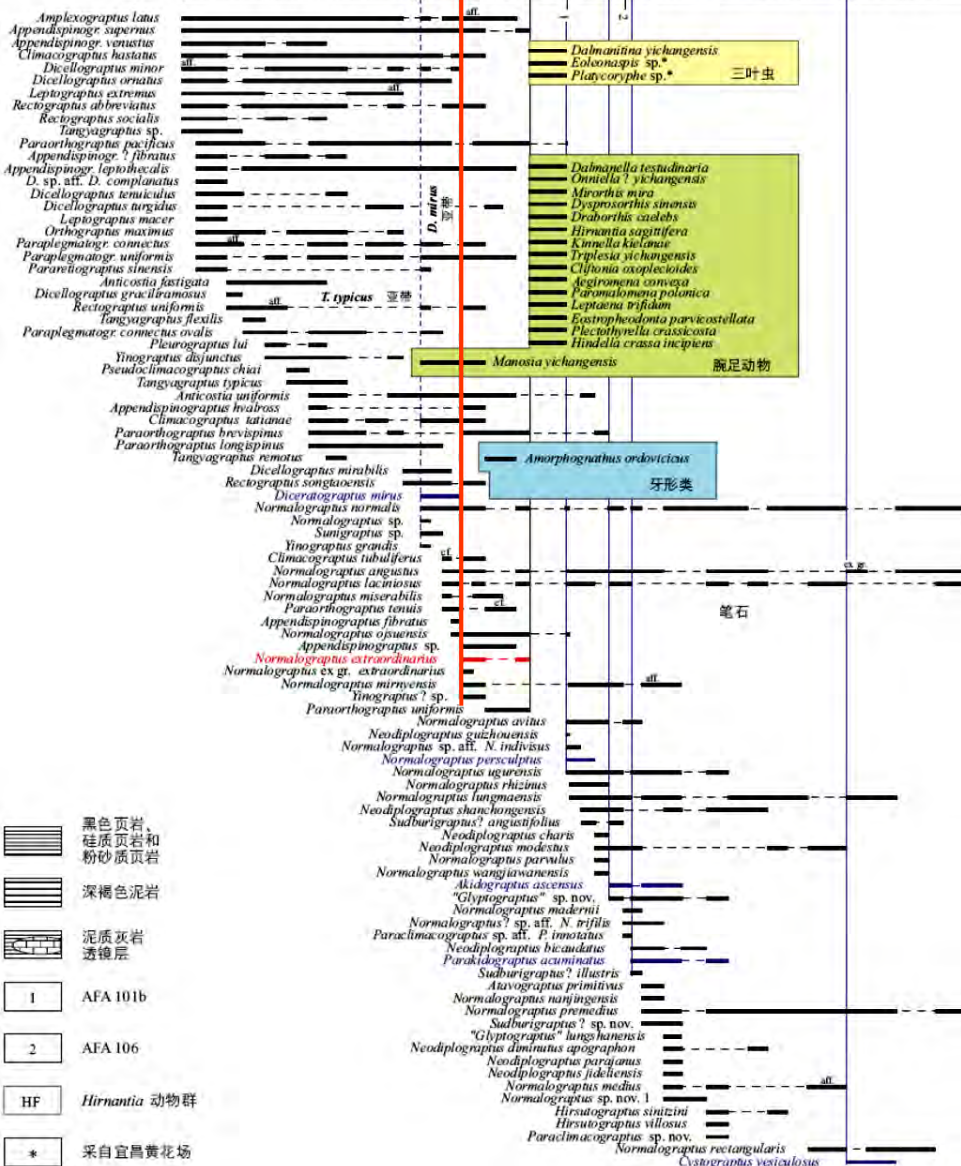


*Normalograptus
extraordinarius*

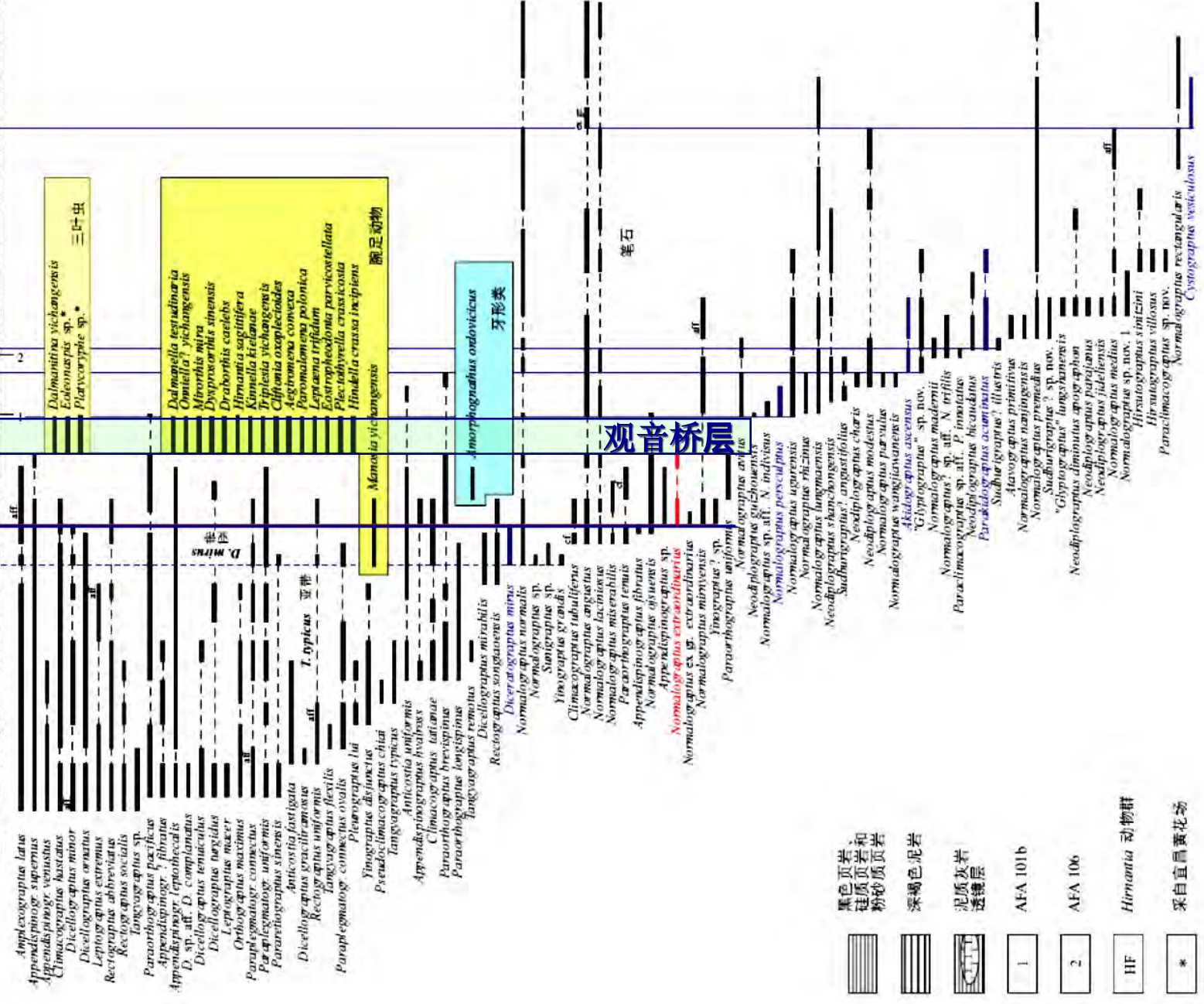




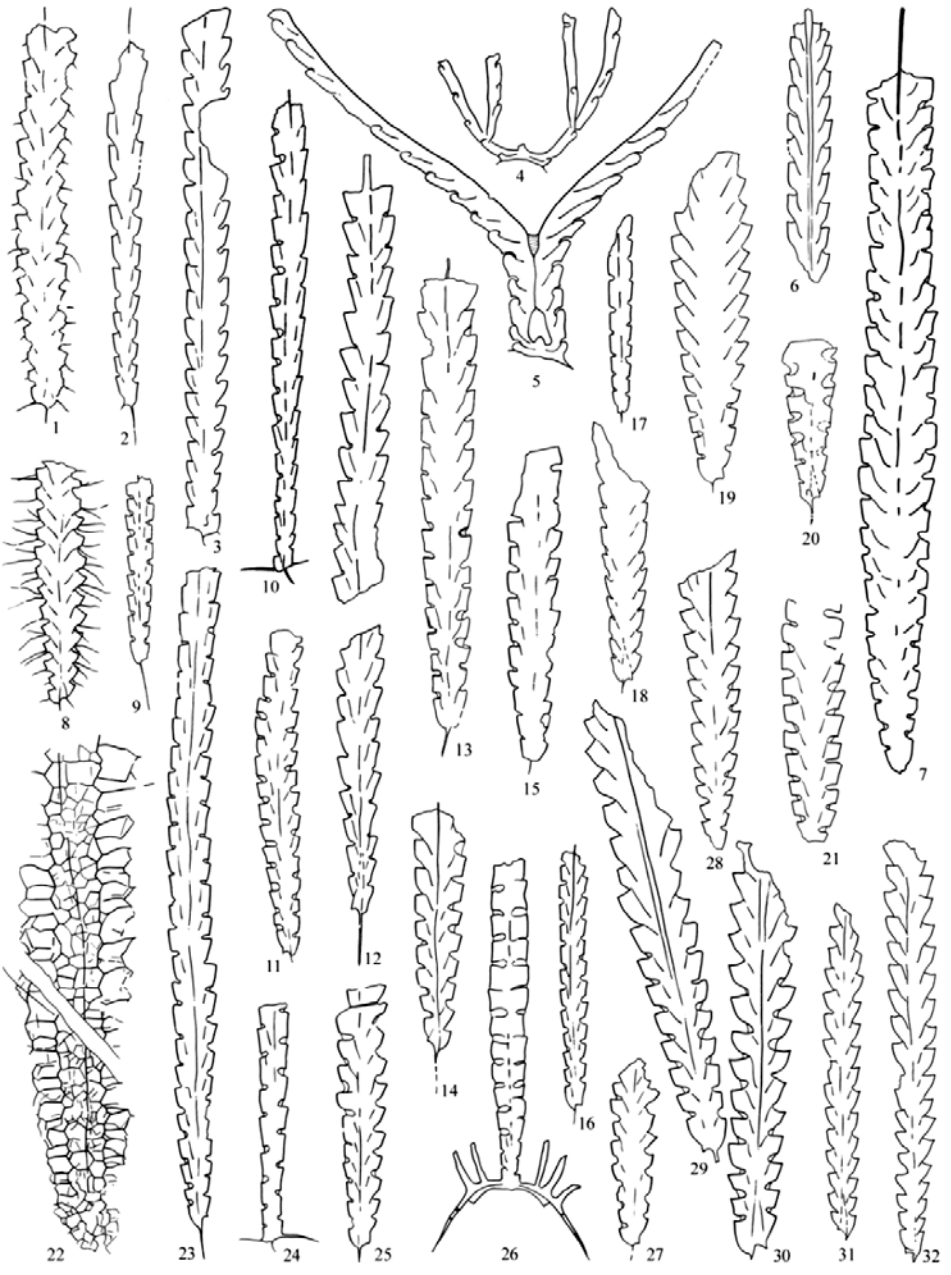
奥陶系										志留系																	
上奥陶统										兰多维尔统																	
凯迪阶					赫南特阶					曹丹阶					龙马溪组												
五峰组										龙马溪组																	
P. pacificus										N. extraordinarius					HF		N. pers-cubicus		A. ascerens		P. acuminatus					C. vesiculosus	
AFA101	AFA102	AFA103	AFA104	AFA105	AFA106	AFA107	AFA108	AFA109	AFA110	AFA111	AFA112	AFA113	AFA114	AFA115	AFA116	AFA117	AFA118	AFA119	AFA120	AFA121	AFA122						



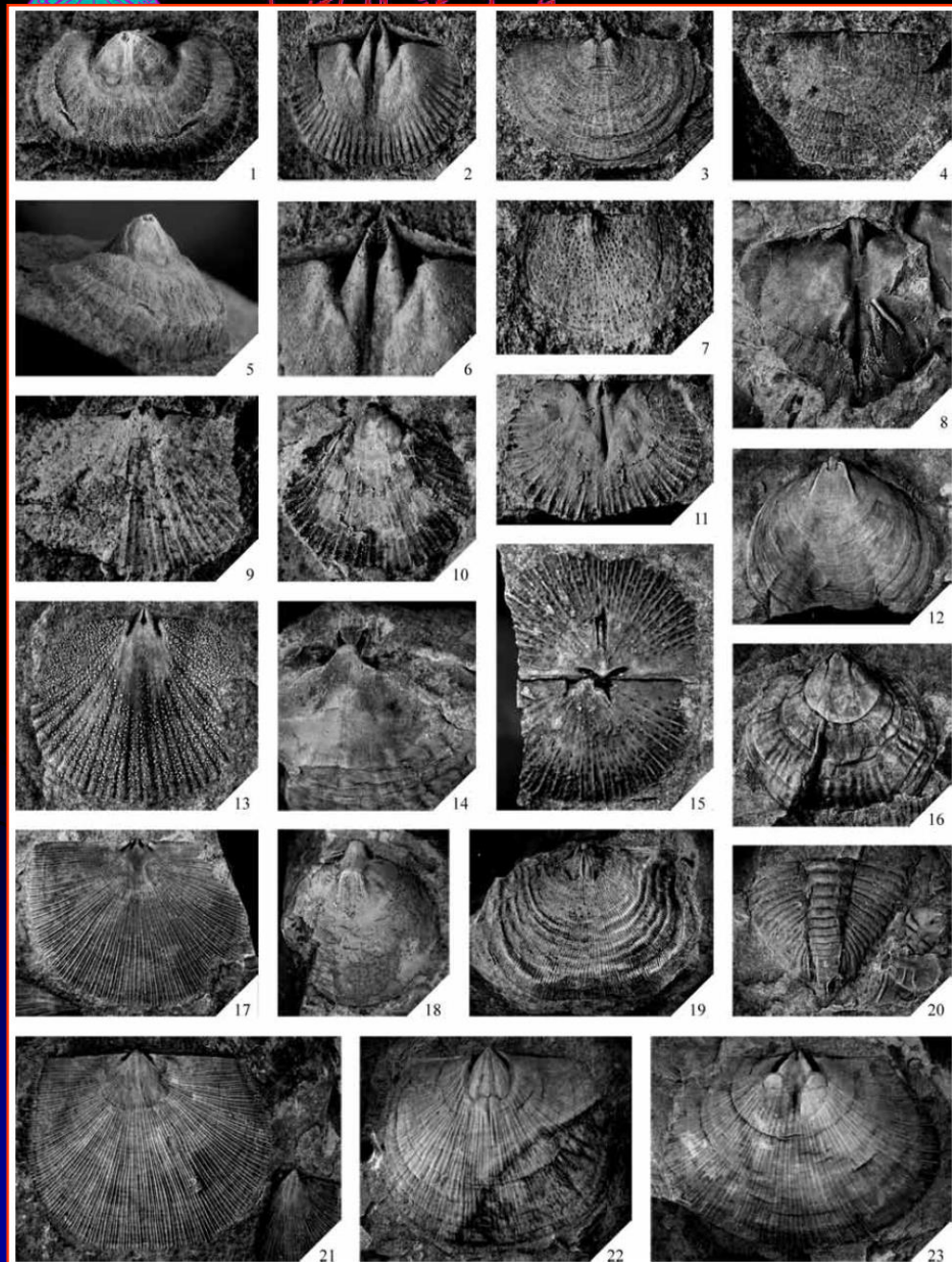
奥陶系		赫南特阶		志留系	
上奥陶统		五峰组		兰多组	
凯迪阶		P. pacificus		曹丹阶	
		N. e. grandinarum		龙马溪组	
		HF		P. acuminatus	
		AFA 100		AFA 116	
		AFA 99		AFA 115	
		AFA 98		AFA 114	
		AFA 98a		AFA 113	
		AFA 97b		AFA 112	
		AFA 97a		AFA 111	
		AFA 96		AFA 110	
		AFA 96a		AFA 109	
		AFA 95		AFA 108	
		AFA 95a		AFA 107	
		AFA 94		AFA 105	
		AFA 94a		AFA 104	
		AFA 93		AFA 103	
		AFA 92		AFA 102	
		AFA 91			
		AFA 90			
		AFA 89			
		AFA 88			
		AFA 87			
		AFA 86			
		AFA 85			
		AFA 84			
		AFA 83			
				AFA 120	
				AFA 119	
				AFA 118	
				AFA 117	







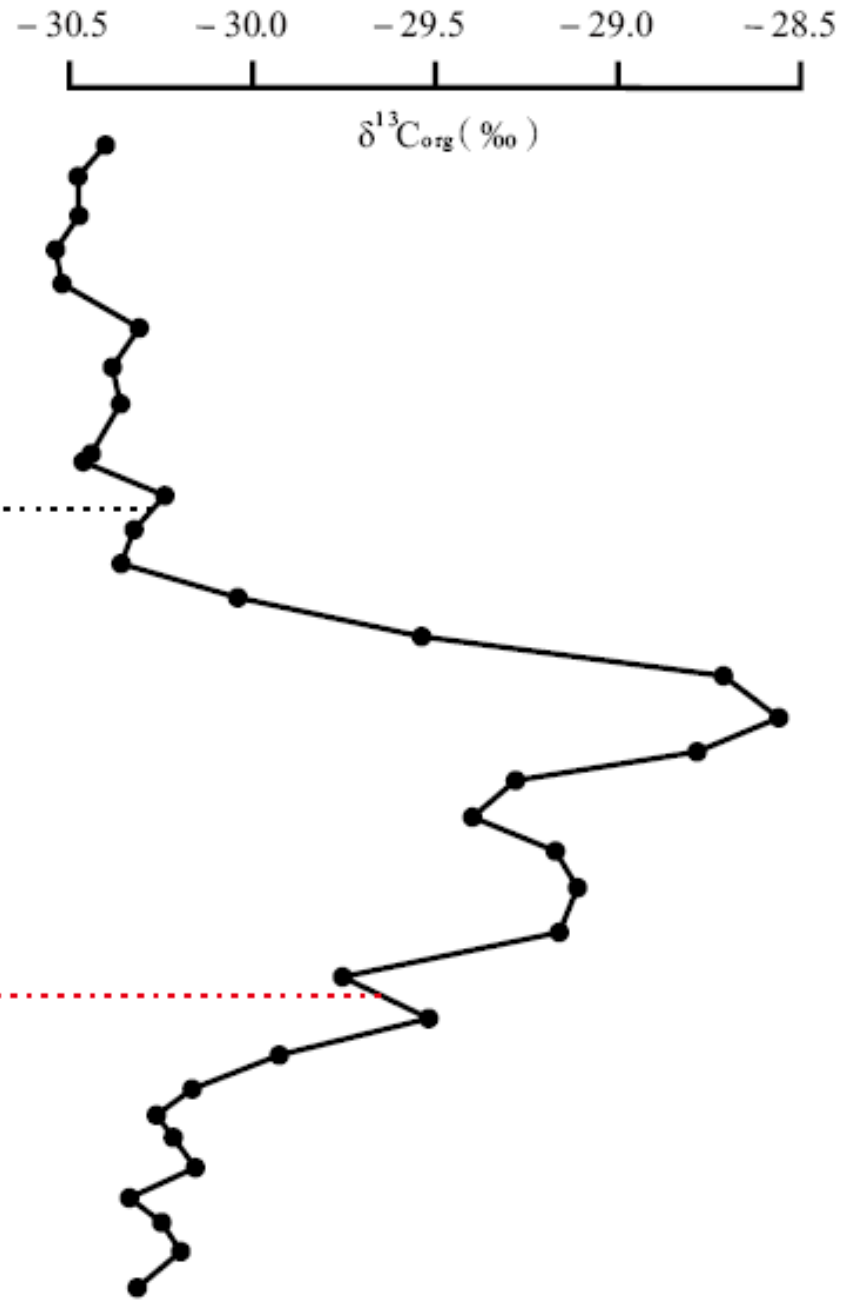
1. *Paraorthograptus uniformis* Mu & Li: *N. extraordinarius* 带底部 (WW105-117), NIGP 136732;
2. *Normalograptus rhizinus* (Li & Yang): *N. persculptus* 带顶部 (WL 28-35), NIGP 136739;
3. *Anticostia uniformis* (Mu & Lin): *T. typicus* 亚带 (WW 17-24), NIGP 136733;
4. *Tangyagraptus typicus* Mu: *T. typicus* 亚带底部 (WW 0-17), NIGP 136734;
5. *Diceratograptus mirus* Mu: *D. mirus* 亚带底部 (WW 87-95), NIGP 136735;
6. 18. *Normalograptus persculptus* (Elles & Wood): 6. *N. persculptus* 带底部 (WL 0-6), NIGP 136753;
18. *N. persculptus* 带 (AFA 102), NIGP 133453;
7. 20. 21. *Normalograptus extraordinarius* (Elles & Wood): 7. *N. extraordinarius* 带上部 (2.20~2.28 m),
NIGP136749; 20. *N. extraordinarius* 带底部 (AFA 97), NIGP 133407; 21. *N. extraordinarius* 带上部
(WW 127-134), NIGP 136737;
8. *Paraorthograptus pacificus* (Ruedemann): *T. typicus* 顶部 (WW 69-78), NIGP 136740;
9. *Climacograptus tataniae* Keller: *N. extraordinarius* 带底部 (AFA 97), NIGP 133370;
10. *Appendispinograptus leptothecalis* (Mu & Ge): *N. extraordinarius* 带 (AFA 98), NIGP 133381;
11. *Normalograptus parvulus* (H. Lapworth): *N. persculptus* 带底部 (WL 0-6), NIGP 136751;
12. 23. *Normalograptus avitus* (Davies): 12. *N. persculptus* 带 (AFA 104), NIGP 133344; 23. *N. persculptus* 带底
部 (WL 0-6), NIGP 136742;
13. 14. 15. 29. 30. *Normalograptus ojsuensis* (Koren' & Mikhailova): 13. *N. extraordinarius* 带 (AFA 99), NIGP
133446; 14. *N. extraordinarius* 带底部 (WW 105-117), NIGP 136747; 15. *D. mirus* 亚带顶部 (AFA96b), NIGP
136736; 29, 30. *N. extraordinarius* 带下部 (WW 105-117), NIGP 136748, 136748-1;
16. *Normalograptus mirnyensis* (Obut & Sobolevskaia): *N. persculptus* 带底部 (WL 0-6), NIGP 136746;
17. *Normalograptus miserabilis* (Elles & Wood): *N. extraordinarius* 带底部 (WW 105-117), NIGP 136738;
19. *Neodiplograptus modestus* (Lapworth): *N. persculptus* 带顶部 (WL 28-35), NIGP 136731;
22. *Paraplegmatograptus uniformis* Mu: *T. typicus* 亚带下部 (WW 24-42), NIGP 136741;
24. *Appendispinograptus supernus* (Elles & Wood): *N. extraordinarius* 带底部 (WW105-117), NIGP 136743;
25. 27. *Normalograptus* sp.: *D. mirus* 亚带下部 (AFA95a), NIGP 136745-1, 136745;
26. *Appendispinograptus venustus* (Hsü): *T. typicus* 亚带下部 (WW 24-42), NIGP 136750;
28. *Neodiplograptus daedalus* (Mu & Ni): *N. persculptus* 带 (WL 12-21), NIGP 136754;
31. 32. *Normalograptus laciniatus* (Churkin & Carter): 31. *N. persculptus* 带底部 (WL 0-6), NIGP 136752;
32. *N. persculptus* 带 (AFA 102), NIGP 133417.



- 1, 2, 5, 6. *Kinnella kielanae* (Temple): 1, 5. 腹内膜 (前侧视), $\times 6.25$, $\times 7.08$, NIGP 136755; 2, 6. 背内膜及其主基放大, $\times 6.5$, $\times 11.67$, NIGP 136756;
- 3, 4, 7. *Paromalomena polonica* (Temple): 3. 腹内膜, $\times 5$, NIGP 136757; 4, 7. 两个背内膜, $\times 4.83$, $\times 8.5$, NIGP 136758, NIGP 136759;
8. *Plectothyrella crassicosta* (Dalman): 背内膜, $\times 2.67$, NIGP 136760;
- 9, 10. *Dysprosorthis sinensis* Rong: 背、腹内膜, $\times 6.48$, $\times 3.83$, NIGP 136761, NIGP 136762;
11. *Draborthis caelebs* Marek & Havlicek: 背内膜, $\times 3.33$, NIGP 136763;
12. *Triplesia yichangensis* Zeng: 腹内膜, $\times 2.5$, NIGP 136764;
13. *Dalmanella testudinaria* (Dalman): 背内膜, $\times 5.33$, NIGP 136765;
- 14, 16. *Cliftonia oxolecioides* (Wright): 背、腹内膜, $\times 2.5$, $\times 4.33$, NIGP 136766, NIGP 136767;
15. *Aegiromena ultima* (Marek & Havlicek): 腹、背内膜, $\times 7.25$, NIGP 136768;
- 17, 21. *Eostropheodonta parvicostellata* (Rong): 背、腹内膜, $\times 4.08$, $\times 1.67$, NIGP 136769, NIGP 136770;
18. *Hindella crassa incipiens* (Williams): 腹内膜, $\times 1.5$, NIGP 136771;
19. *Leptaena trifidum* (Marek & Havlicek): 背内膜, $\times 1.5$, NIGP 136772;
20. *Dalmanitina* sp.: 尾部并伴有一小头盖, $\times 3.33$, NIGP 136773;
- 22, 23. *Hirnantia sagittifera* (McCoy): 腹、背内膜, $\times 1.58$, $\times 1.92$, NIGP 136774, NIGP 136775。



志留系	兰多维列统	鲁丹阶	<i>acuminatus</i>	龙马溪组
			<i>ascensus</i>	
			<i>persculptus</i>	
奥陶系	上奥陶统	赫南特阶	<i>Himantia fauna</i>	观音桥层
			<i>extraordinarius</i>	五峰组
		凯迪阶	<i>pacificus</i>	
			<i>typicus</i>	
			<i>mirus</i>	





中国地质大学

国际 标准	中国扬子区 (Chen <i>et al.</i> 2000, 2006; Rong <i>et al.</i> 2002)	苏格兰 Dob's Linn Williams 1982b 1983, 1988)	丹麦 Bornholm (Koren' & Bjerreskov 1997)	西班牙和葡萄牙 (Gutierrez-Marco <i>et al.</i> 1998)	意大利Sardinia (Storch & Serpagli 1993; Storch & Leone 2003)	德国 (Jaeger 1977, 1988; Schauer 1971)	捷克波希米亚 (Storch 1988; Storch & Loyde II 1996)	波兰 (Teller 1969)	澳大利亚 Central Victoria (Vandenberg <i>et al.</i> 1984)	中国西藏申扎 (Mu & Ni 1983)
志留系 兰多维列统 鲁丹阶	<i>P. acuminatus</i>	<i>P. acuminatus</i>	<i>P. acuminatus</i>	<i>P. acuminatus</i> - <i>A. ascensus</i>	<i>P. acuminatus</i>	<i>P. acuminatus</i>	<i>P. acuminatus</i>	<i>P. acuminatus</i>	<i>P. acuminatus</i>	<i>P. acuminatus</i>
	<i>A. ascensus</i>	<i>A. ascensus</i>	<i>A. ascensus</i>		<i>A. ascensus</i>	<i>A. ascensus</i>	<i>A. ascensus</i>	<i>A. ascensus</i>		<i>A. ascensus</i>
奥陶系 上奥陶统 赫南特阶 凯迪阶	<i>Himantia</i> 动物群 <i>N. persculptus</i> <i>N. extraord.</i>	<i>N. persculptus</i>	<i>N. persculptus</i>	<i>Himantia</i> fauna	<i>Himantia</i> fauna	<i>N. persculptus</i>	HF <i>N. persculptus</i>	<i>N. persculptus</i>	<i>N. persculptus</i>	<i>N. persculptus</i>
		<i>Manosia</i> <i>P. pacificus</i>	<i>D. anceps</i>		<i>P. pacificus</i>	<i>N. extraord.</i> - <i>N. ojsuensis</i>		<i>M. mucronata</i> - <i>Hirnantia</i>	<i>N. persculptus</i>	<i>N. persculptus</i>
	<i>D. mirus</i>						<i>D. ornatus</i> - <i>A. latus</i>			
	<i>T. typicus</i>									
下部亚带										

国际 标准	中国扬子区 (Chen <i>et al.</i> 2000, 2006; Rong <i>et al.</i> 2002)	乌兹别克斯坦 (Koren' & Melchin 2000)	哈萨克斯坦南部 (Koren' <i>et al.</i> 1979; Apollonov <i>et al.</i> 1980)	科索马 Mimy Creek (Koren' <i>et al.</i> 1979, 1983, 1988)	马来西亚 Lankawi Island (Jones 1973)	加拿大育空 (Lenz & McCracken 1982, 1988; Chen & Lenz 1984; Melchin 1987)	加拿大极区 (Melchin <i>et al.</i> 1991)	美国内华达 (Finney <i>et al.</i> 1999)	阿根廷 (Cuerda <i>et al.</i> 1988; Brussa <i>et al.</i> 1999)
志留系 兰多维列统 鲁丹阶	<i>P. acuminatus</i>	<i>P. acuminatus</i> - <i>A. ascensus</i>	<i>P. acuminatus</i>	<i>P. acuminatus</i>	<i>Dalmanitina</i> <i>malayensis</i>	<i>P. acuminatus</i>	<i>P. acuminatus</i>	<i>H. sinitzini</i>	<i>P. acuminatus</i>
	<i>A. ascensus</i>		<i>A. ascensus</i>	<i>A. ascensus</i>					
奥陶系 上奥陶统 赫南特阶 凯迪阶	<i>Himantia</i> 动物群 <i>N. persculptus</i> <i>N. extraord.</i>	<i>N. persculptus</i>	HF <i>N. persculptus</i>	<i>N. persculptus</i>	<i>N. persculptus</i>	<i>N. persculptus</i>	<i>N. persculptus</i>	<i>N. persculptus</i>	<i>N. persculptus</i>
	<i>D. mirus</i>								
	下部亚带								

HF: *Himantia*动物群

奥陶系赫南特阶全球界线层型
剖面点

湖北省人民政府 宜昌市人民政府
中国科学院 国土资源部
全国地层委员会
二零一一年八月立

HIRNANTIAN (ORDOVICIAN) GLOBAL
STRATOTYPE SECTION AND POINT(GSSP)

People's Government of Hubei Province
People's Government of Yichang City
Chinese Academy of Sciences
Ministry of Land and Resources
Stratigraphy Committee of China
August of 2011



Monument GSP was opened by Governor
Subramanian Swamy, 20th, December, 2004
Sri Lanka
at the National Science Museum, Colombo
February, 2005

赫南特阶层型剖面保护区

PROTECTIVE ZONE FOR THE STRATOTYPE SECTION OF HIRNANTIAN

Formation of the Wan
lowing the
on the
m



志留系

鲁丹阶

FAD of *A. ascensus*

龙马溪组

0.3m

赫南特阶

观音桥（层）段

五峰组

0.39m

黑页岩段

奥陶系

FAD of *N. extraordinarius*



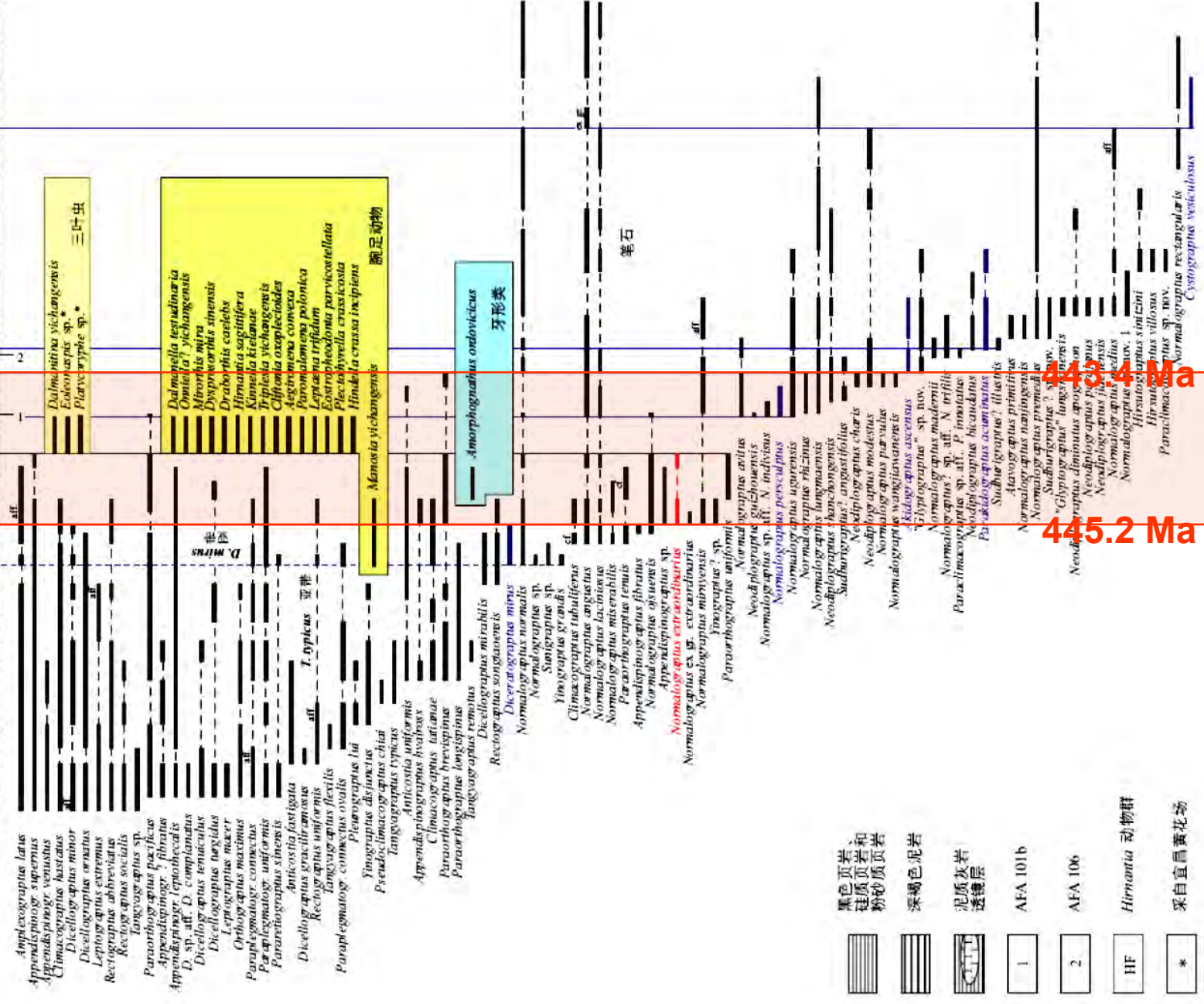
龙马溪组

五峰组

观音桥层



奥陶系		志留系	
上奥陶统		兰多维系统	
凯迪阶		鲁丹阶	
五峰组		龙马溪组	
P. pacificus		P. acuminatus	
N. extramadurus		A. ussuriensis	
N. peracarpinus		HF	
AFA 101a		AFA 104	
AFA 100		AFA 103	
AFA 99		AFA 102	
AFA 98b		AFA 101a	
AFA 98a		AFA 105	
AFA 97b		AFA 104	
AFA 97a		AFA 103	
AFA 96b		AFA 102	
AFA 96a		AFA 101a	
AFA 95b		AFA 100	
AFA 95a		AFA 99	
AFA 94		AFA 98b	
AFA 93		AFA 98a	
AFA 92		AFA 97b	
AFA 91		AFA 97a	
AFA 89		AFA 96b	
AFA 88		AFA 96a	
AFA 87		AFA 95b	
AFA 86		AFA 95a	
AFA 85		AFA 94	
AFA 84		AFA 93	
AFA 83		AFA 92	



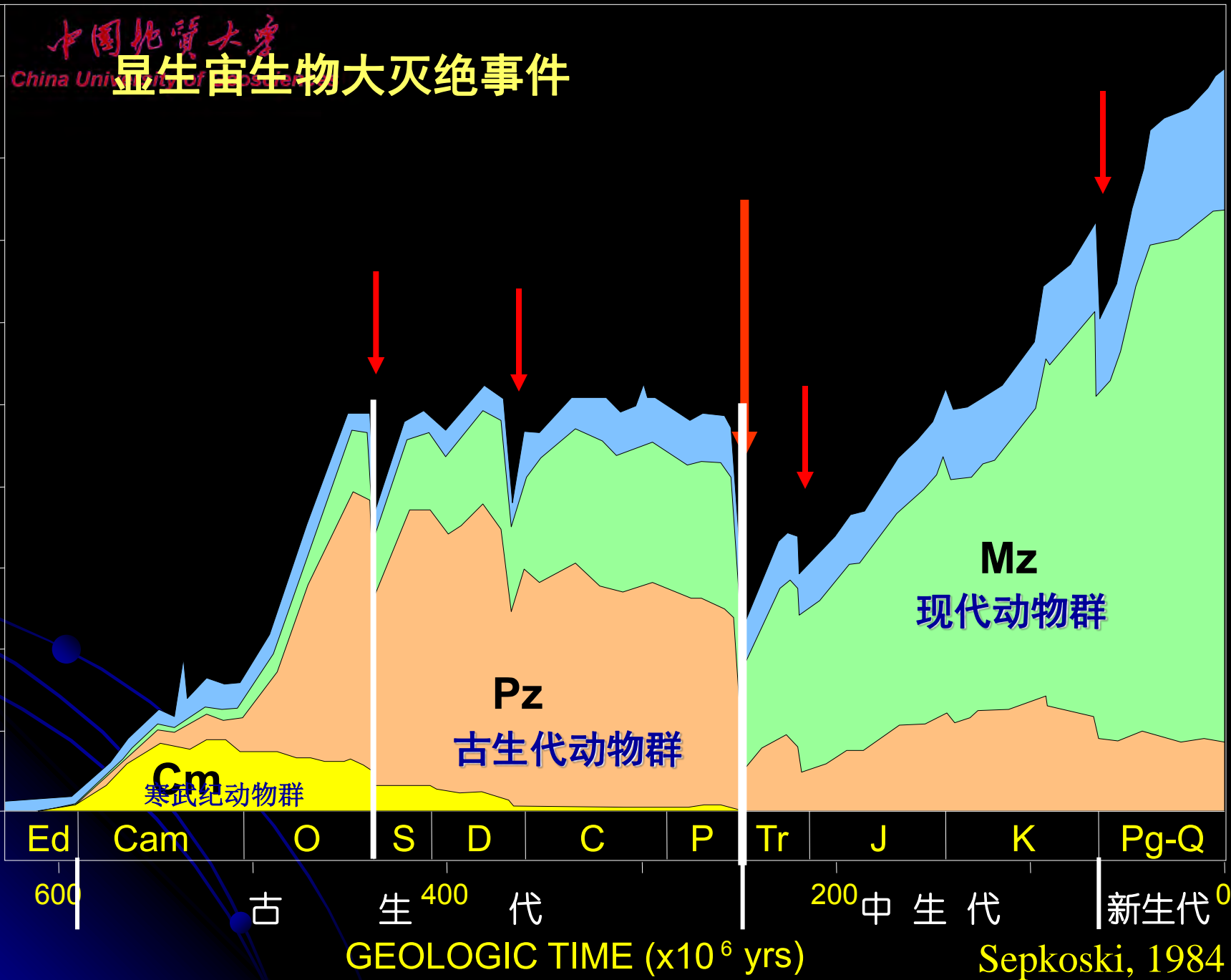
445.4 Ma

445.2 Ma



中国地质大学
China University of Geosciences
显生宙生物大灭绝事件

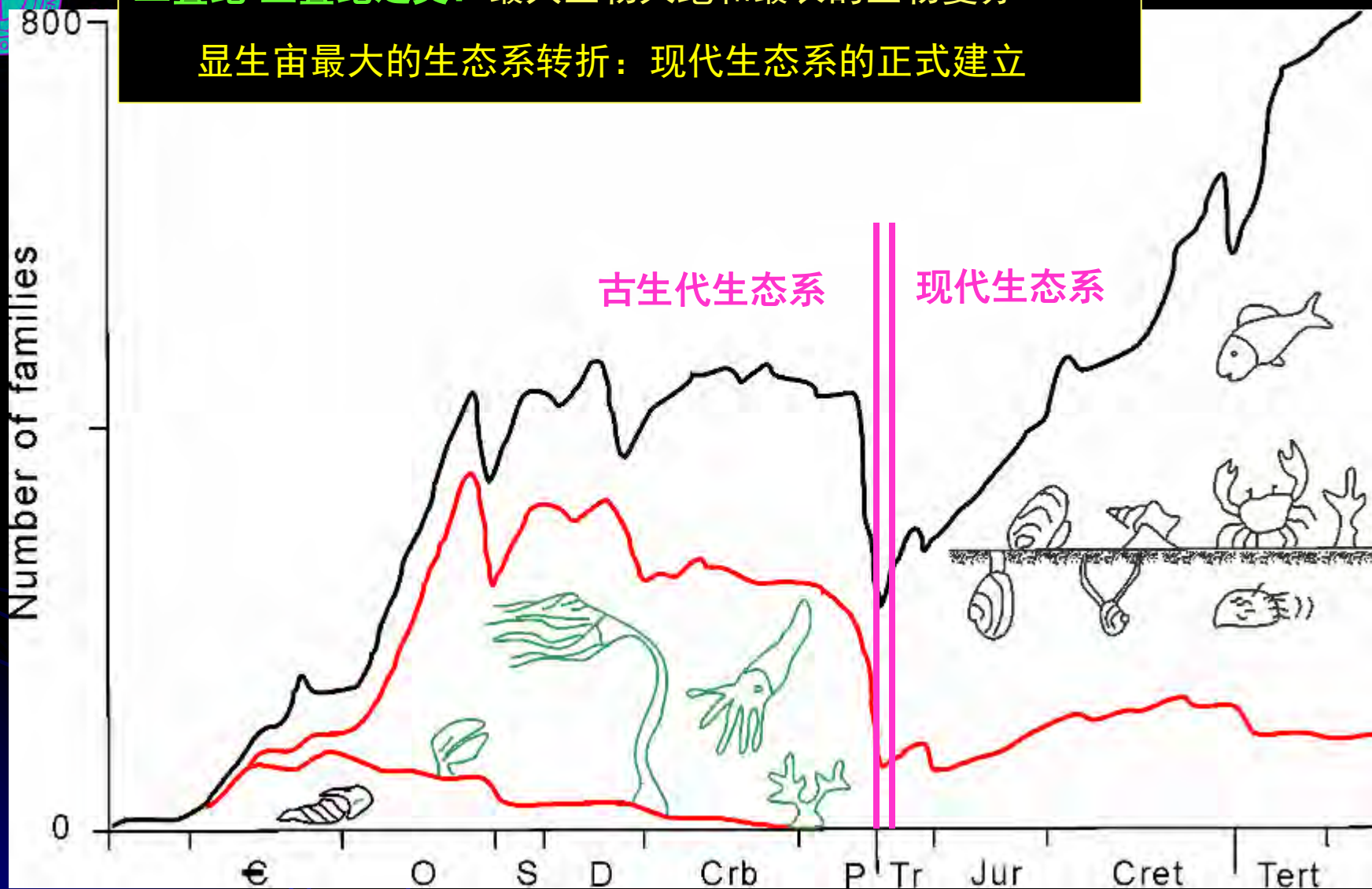
NUMBER OF FAMILIES
科数



GEOLOGIC TIME (x10⁶ yrs)

Sepkoski, 1984

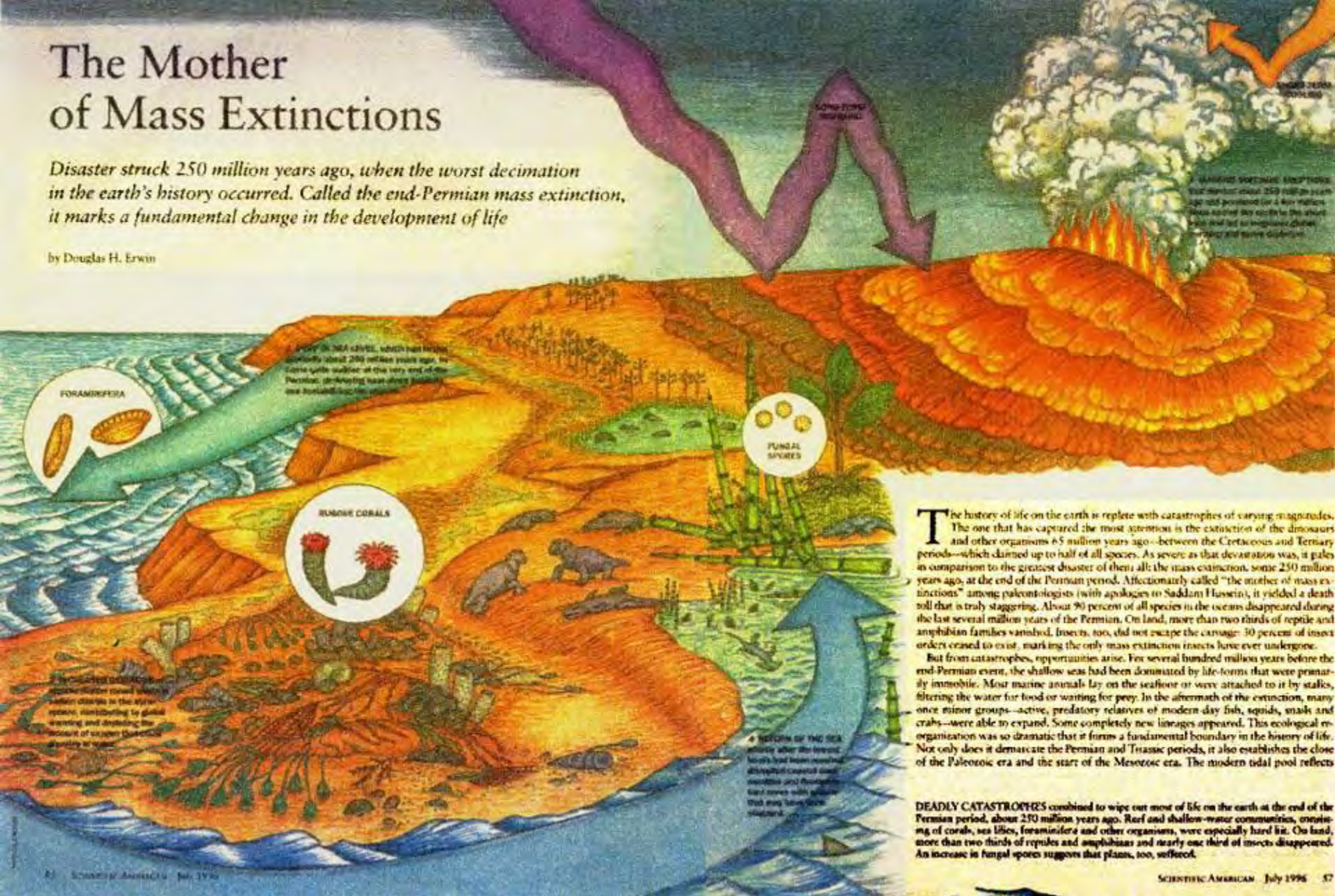
二叠纪-三叠纪之交：最大生物灭绝和最长的生物复苏
显生宙最大的生态系统转折：现代生态系的正式建立



The Mother of Mass Extinctions

Disaster struck 250 million years ago, when the worst decimation in the earth's history occurred. Called the end-Permian mass extinction, it marks a fundamental change in the development of life

by Douglas H. Erwin



Many of the animals, which had begun to flourish about 250 million years ago, became quite scarce at the very end of the Permian, including heat-loving reptiles and four-legged mammals.

FORAMIFERA

RUBROE CORALS

FUNGAL SPORES

The end-Permian mass extinction was a major event in the history of life, marking the end of the Permian and the beginning of the Triassic. It is the most severe mass extinction in the history of life, with about 90 percent of all species in the oceans and 70 percent of all species on land disappearing.

A SECTION OF THE SEA where after the event, life had been nearly wiped out. Only a few plants and animals had survived, and many of these were small and simple.

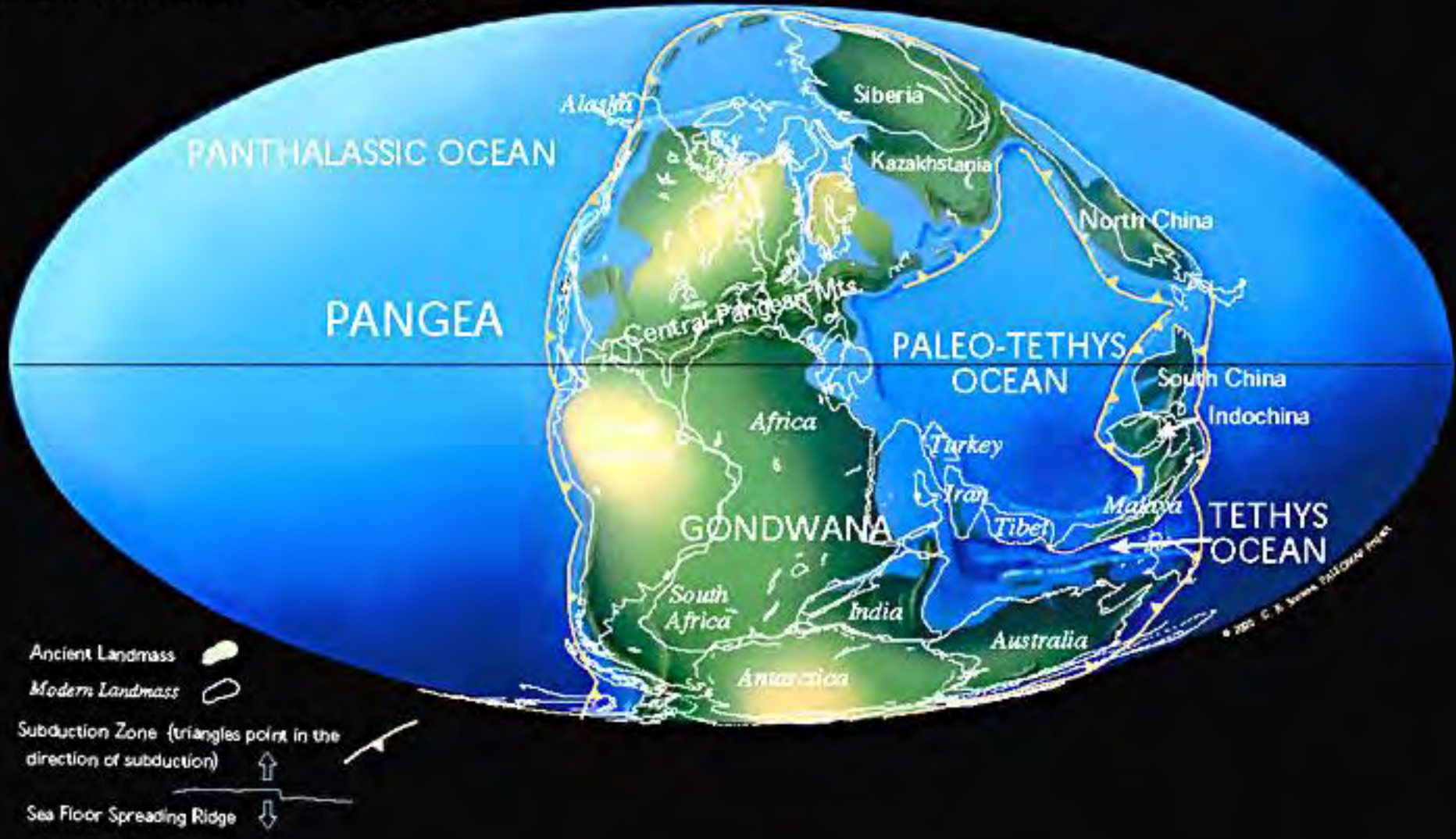
The history of life on the earth is replete with catastrophes of varying magnitudes. The one that has captured the most attention is the extinction of the dinosaurs and other organisms 65 million years ago—between the Cretaceous and Tertiary periods—which claimed up to half of all species. As severe as that devastation was, it pales in comparison to the greatest disaster of them all: the mass extinction, some 250 million years ago, at the end of the Permian period. Affectionately called “the mother of mass extinctions” among paleontologists (with apologies to Saddam Hussein), it yielded a death toll that is truly staggering. About 90 percent of all species in the oceans disappeared during the last several million years of the Permian. On land, more than two thirds of reptile and amphibian families vanished. Insects, too, did not escape the carnage: 30 percent of insect orders ceased to exist, marking the only mass extinction insects have ever undergone.

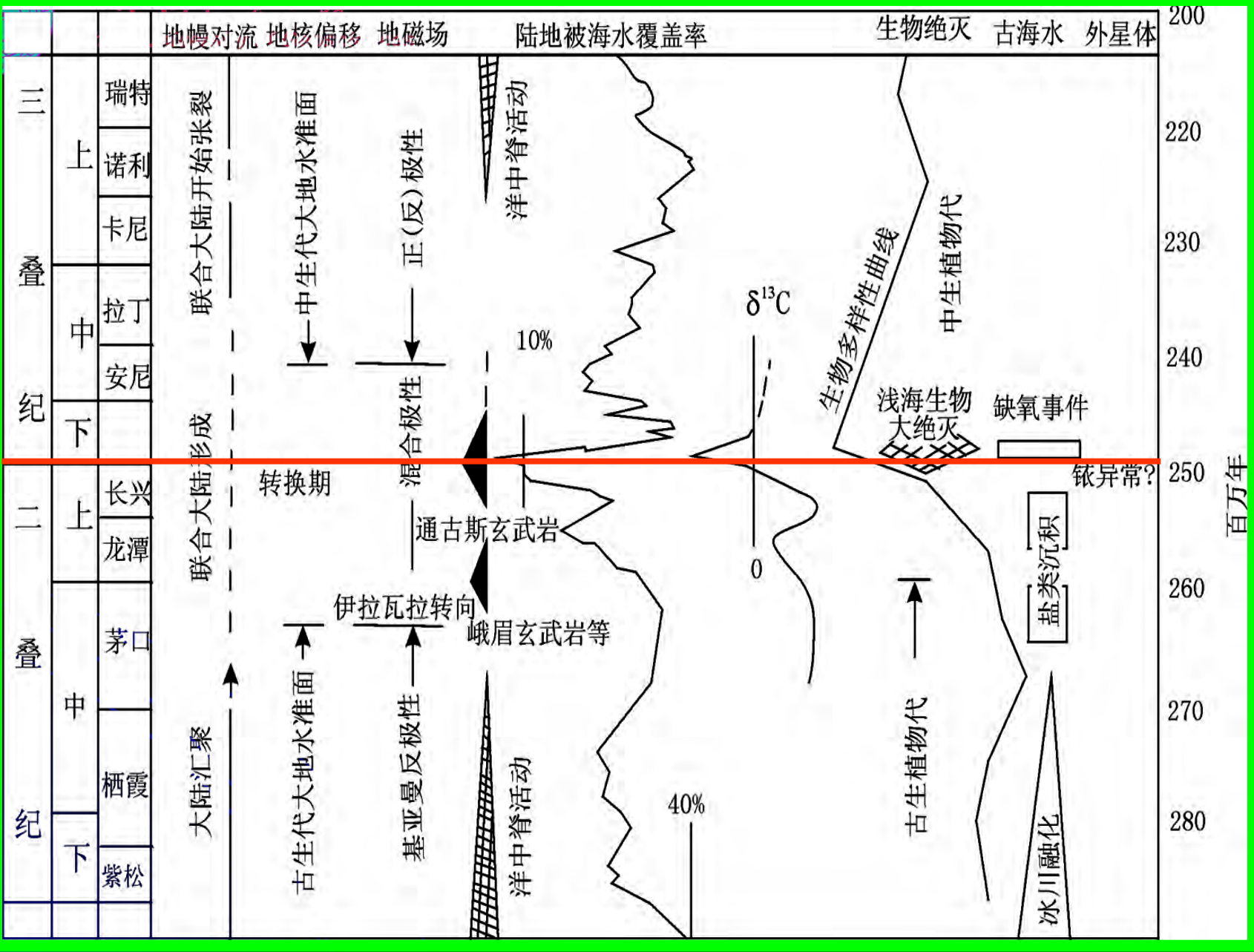
But from catastrophes, opportunities arise. For several hundred million years before the end-Permian event, the shallow seas had been dominated by life-forms that were primarily immobile. Most marine animals lay on the seafloor or were attached to it by stalks, filtering the water for food or waiting for prey. In the aftermath of the extinction, many once minor groups—active, predatory relatives of modern-day fish, squids, snails and crabs—were able to expand. Some completely new lineages appeared. This ecological reorganization was so dramatic that it forms a fundamental boundary in the history of life. Not only does it demarcate the Permian and Triassic periods, it also establishes the close of the Paleozoic era and the start of the Mesozoic era. The modern tidal pool reflects

DEADLY CATASTROPHES combined to wipe out most of life on the earth at the end of the Permian period, about 250 million years ago. Reef and shallow-water communities, consisting of corals, sea lilies, foraminifera and other organisms, were especially hard hit. On land, more than two thirds of reptiles and amphibians and nearly one third of insects disappeared. An increase in fungal spores suggests that plants, too, suffered.



Late Permian 255 Ma

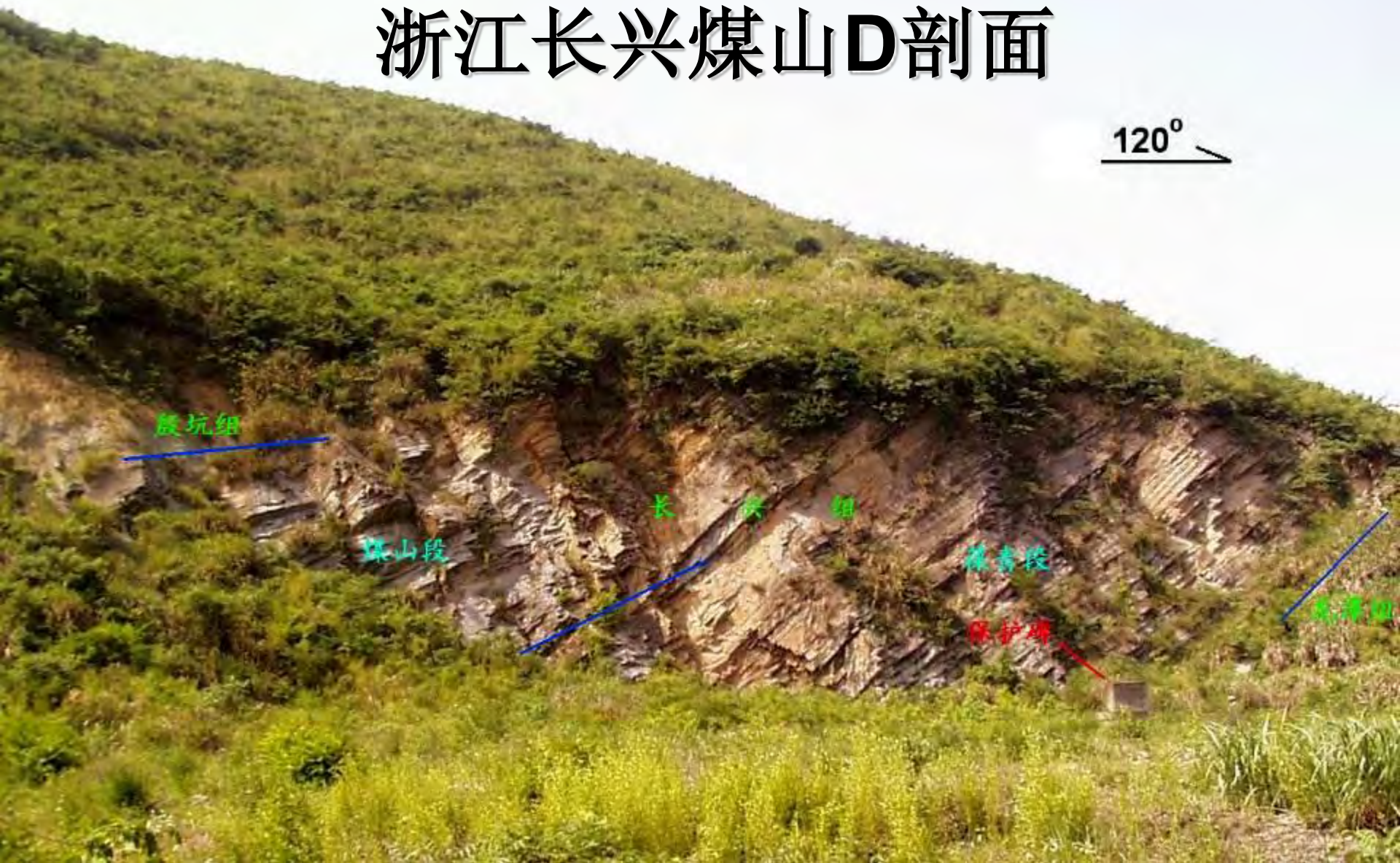




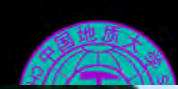


浙江长兴煤山D剖面

120°



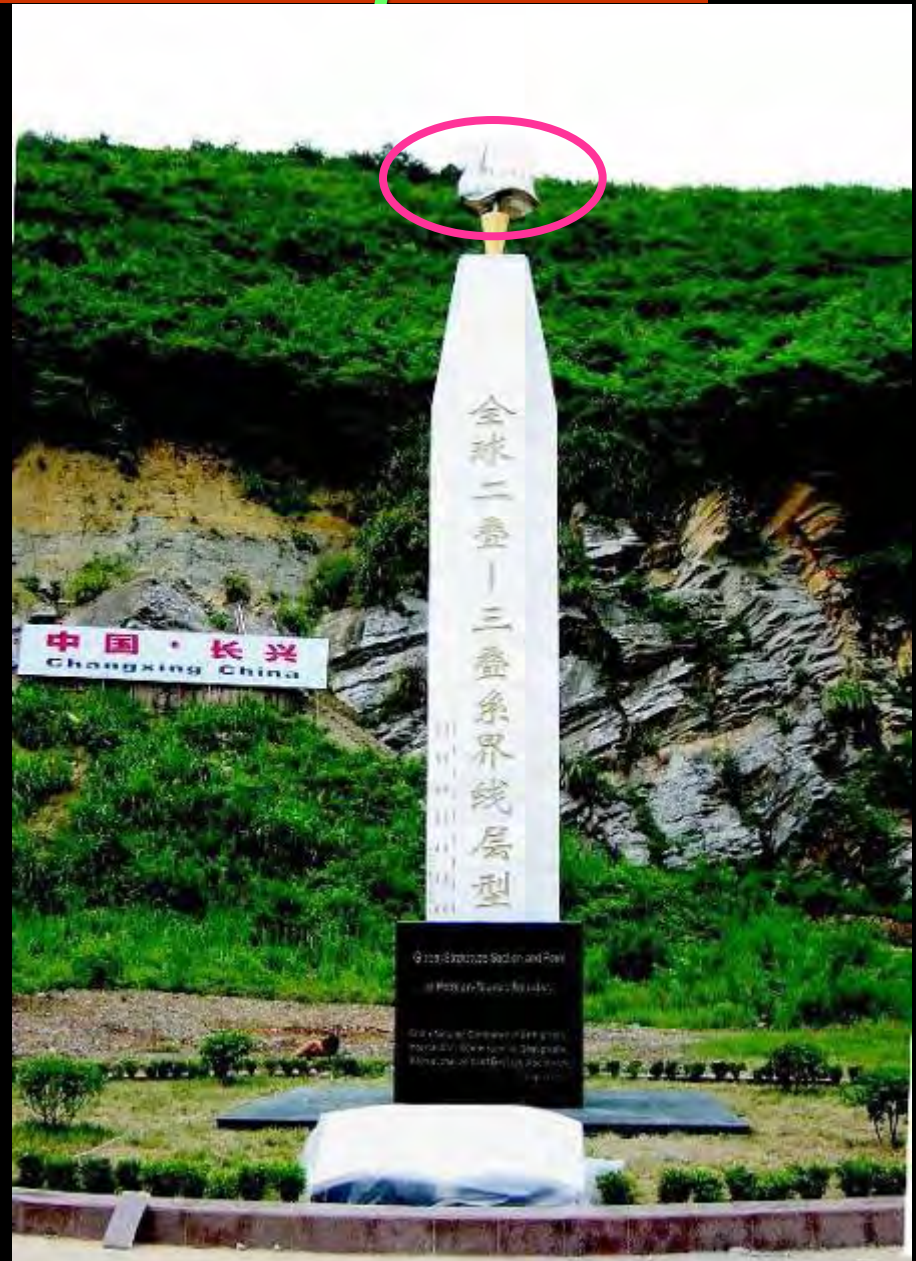
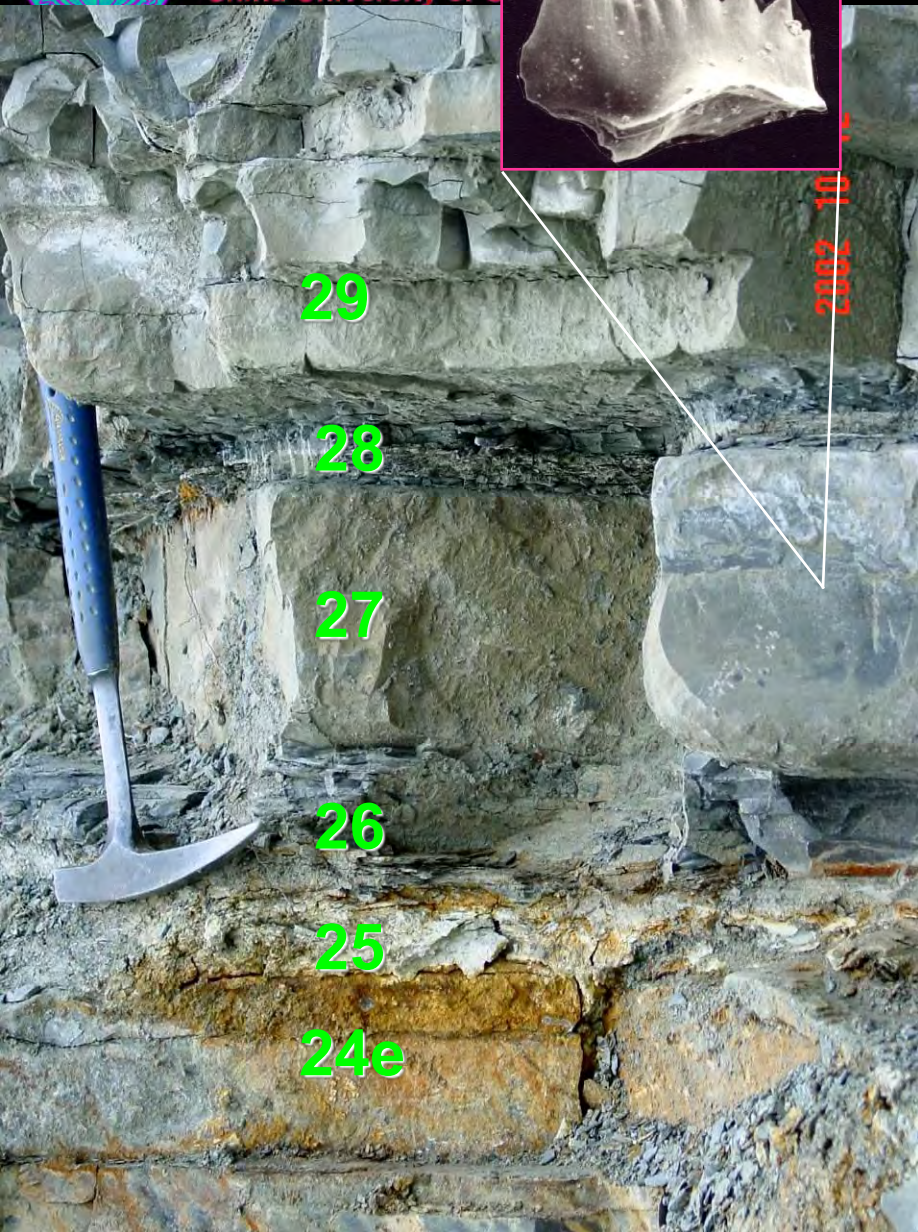


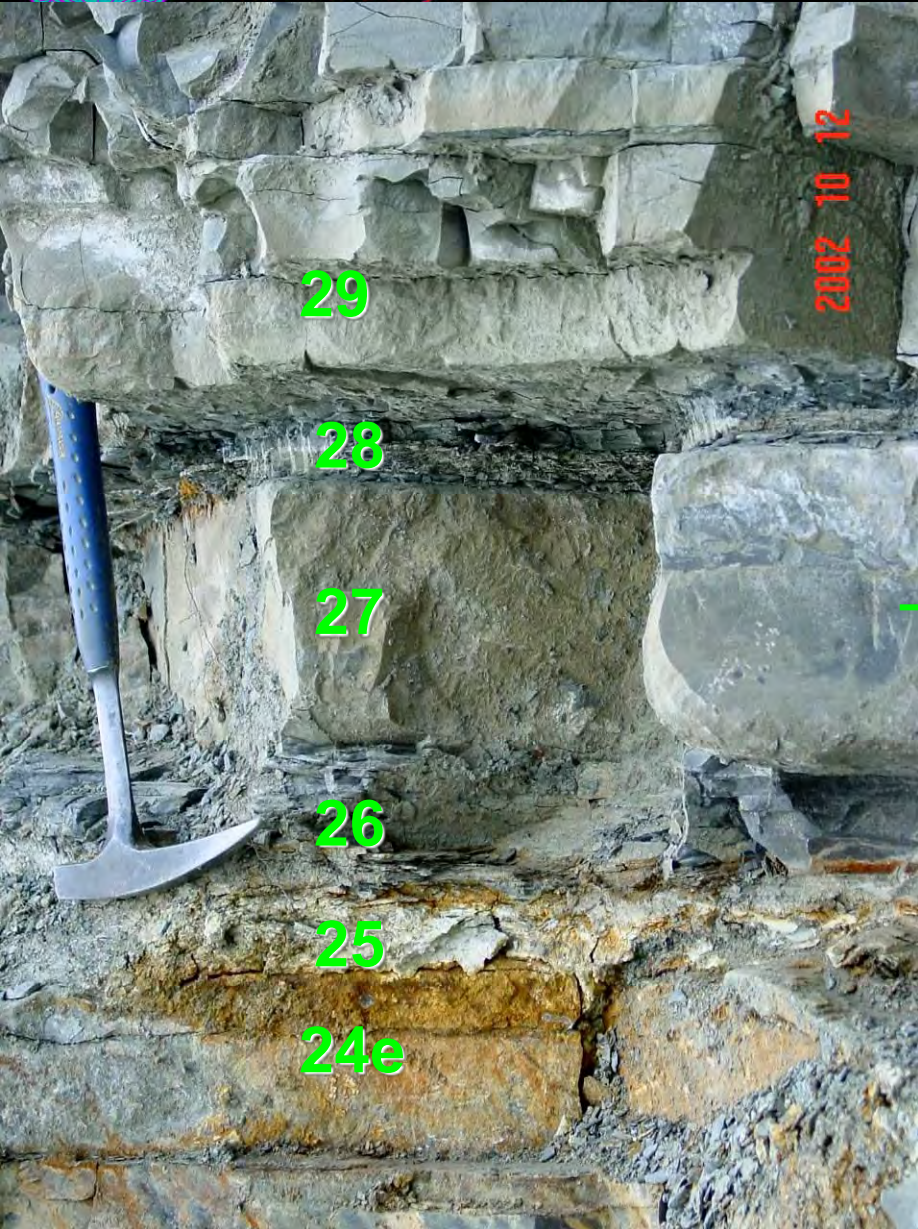




中国地质大学
China University of Geosciences

Hindeodus parvus





Isarcicella isarcica Zone

Isarcicella staeschei Zone

Hindeodus parvus Zone

GSSP

Hind. changxingensis Zone

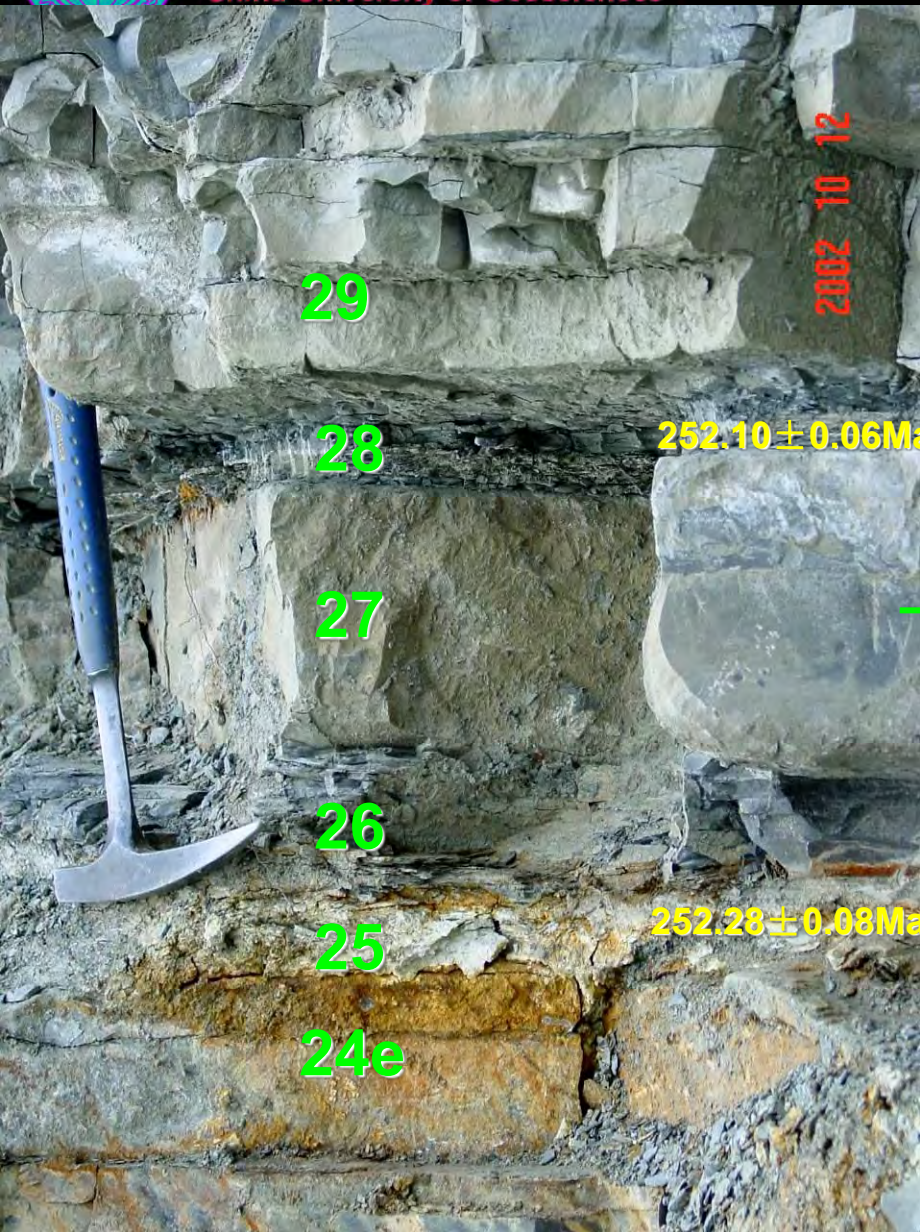
Neog. meishanensis Zone

Neogondolella yini Zone



中国地质 PTB 国际标准

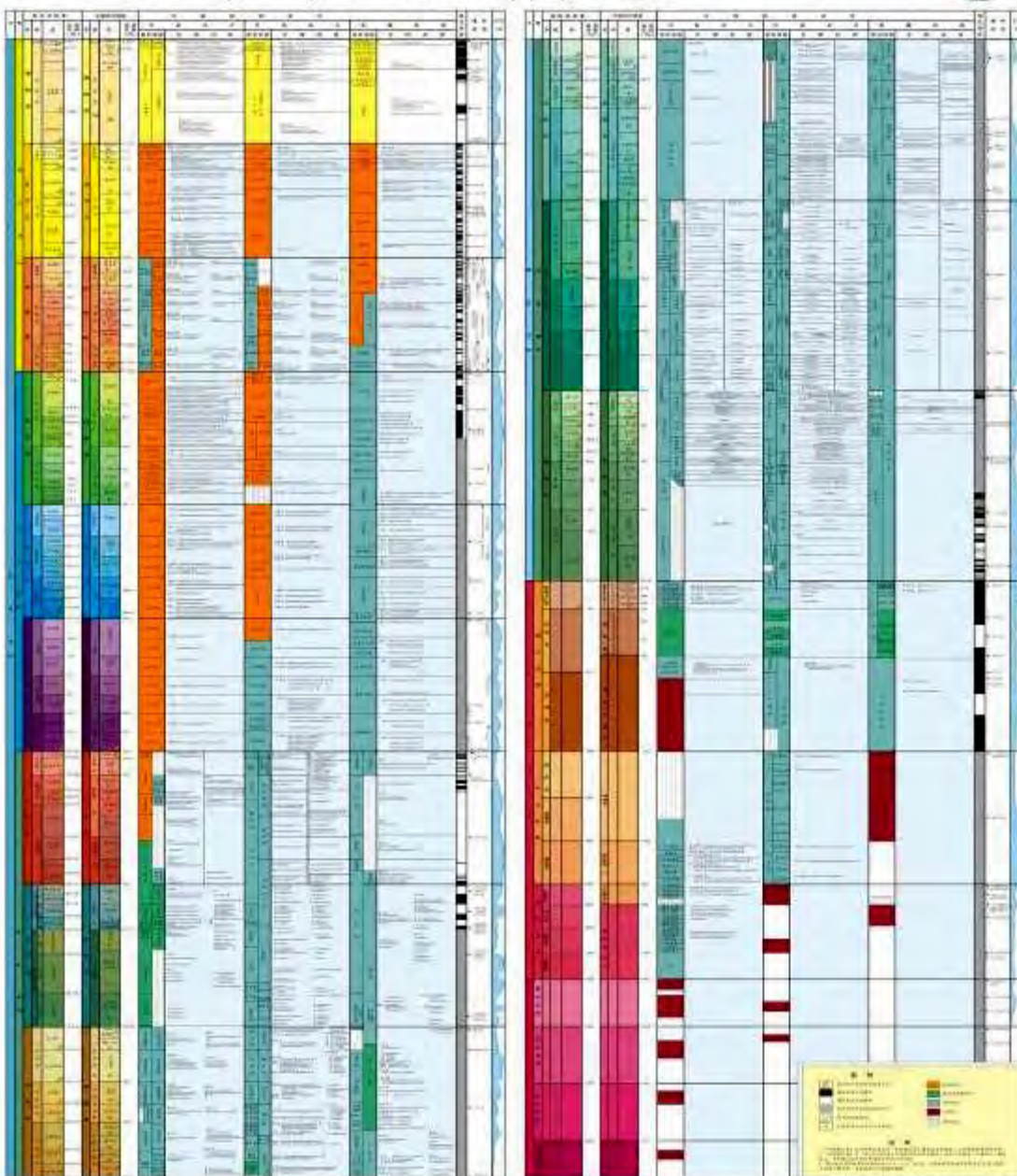
China University of Geosciences

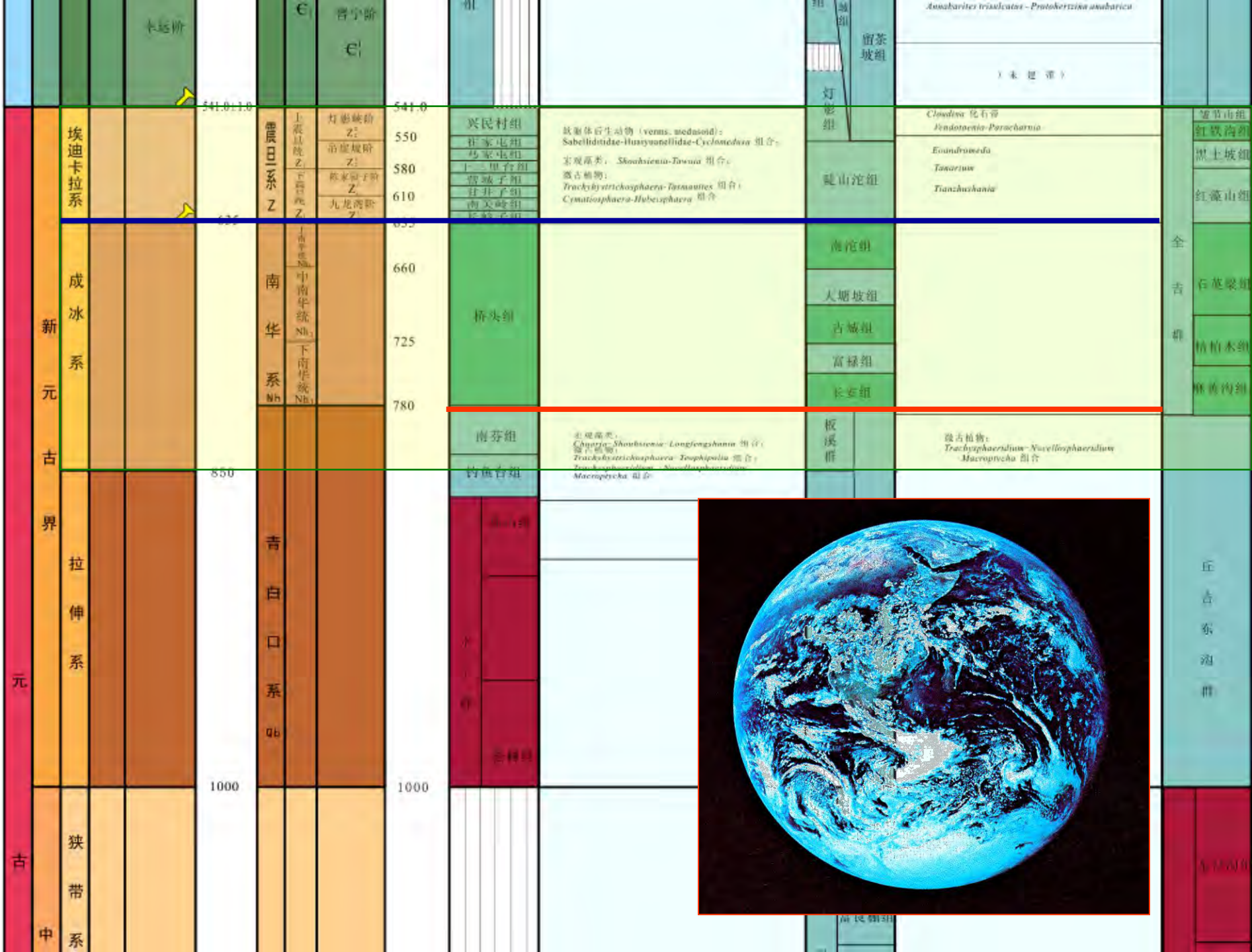


粘
2
“黑
“白
长



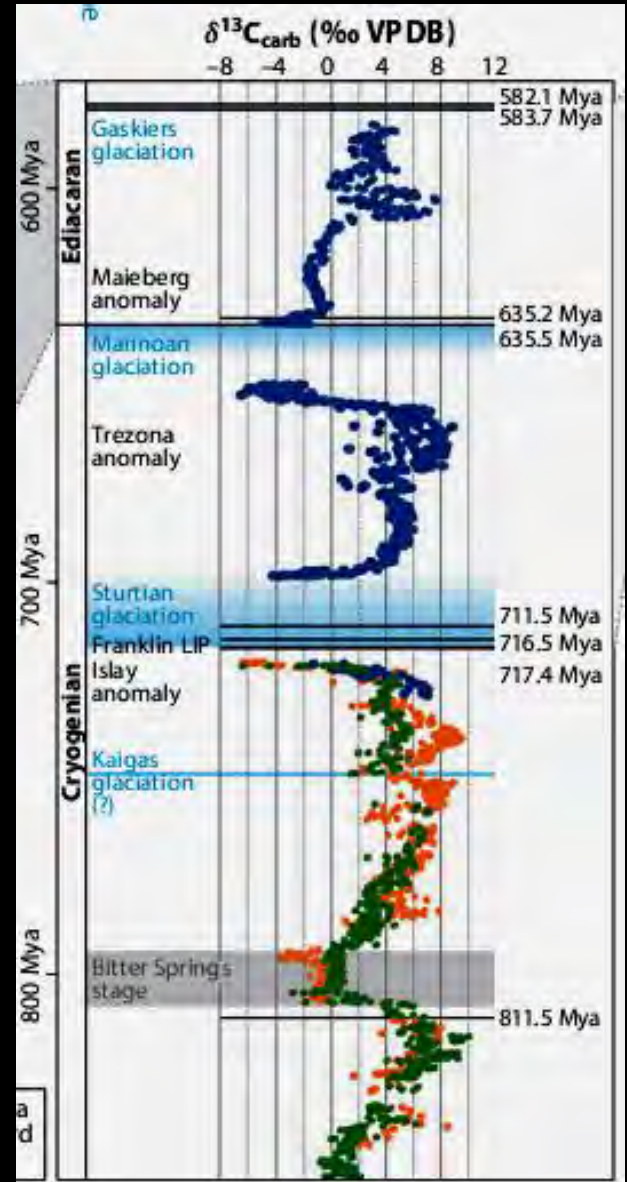
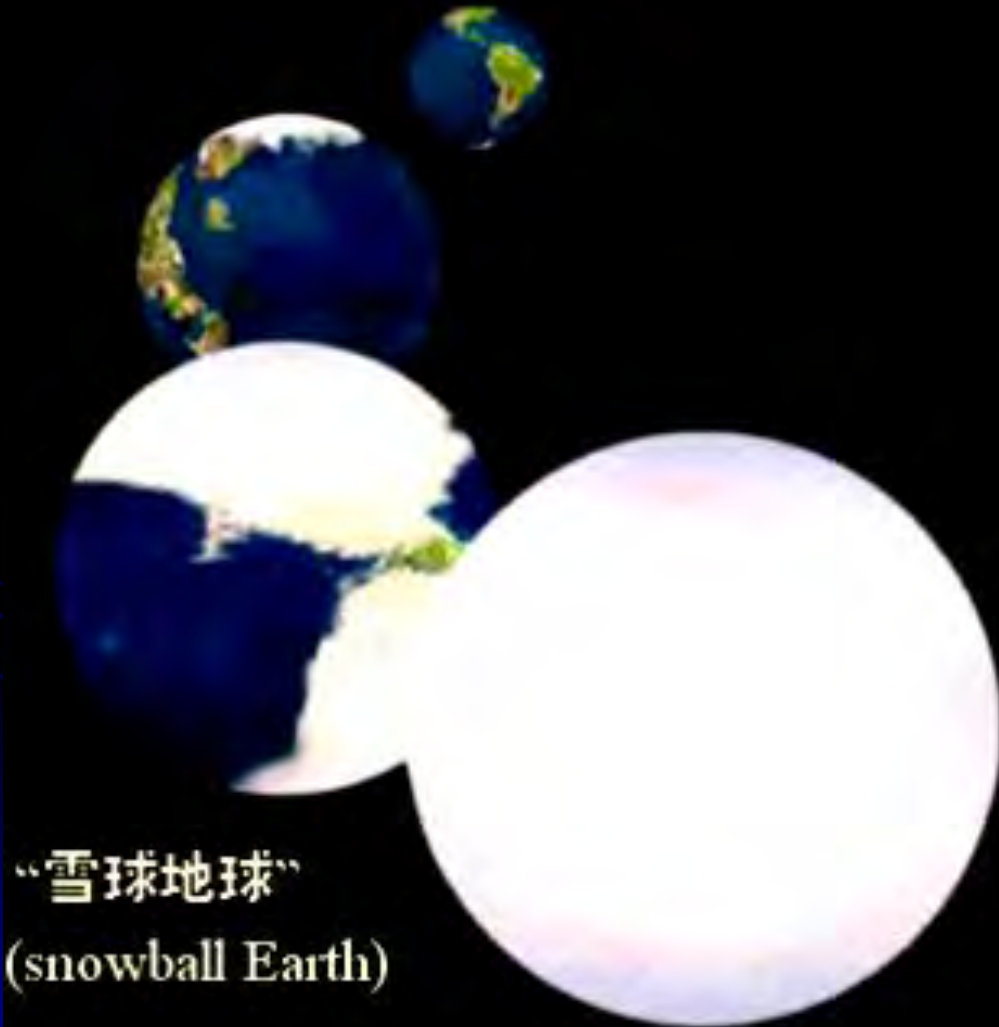
中国地层表 (试用稿)







雪球地球



区域

全球

全球

区域



澳大利亚冰碛岩

Moonlight Valley



glacial marine tills, Ghaub Fm, Namibia



南沱组冰碛岩

宜昌



宜昌



帽碳酸盐岩

冰碛岩

Contact between glacial marine Ghaub Fm (DF, debris flows; IRD, ice-rafted debris) & Keilberg Mb (CD, post-glacial cap dolostone) on Otavi foreslope, northern Namibia.



澳大利亚盖帽白云岩

Moonlight Valley

冰碛岩



陡山沱组
“帽碳酸盐岩”

冰碛岩

宜昌



神农架

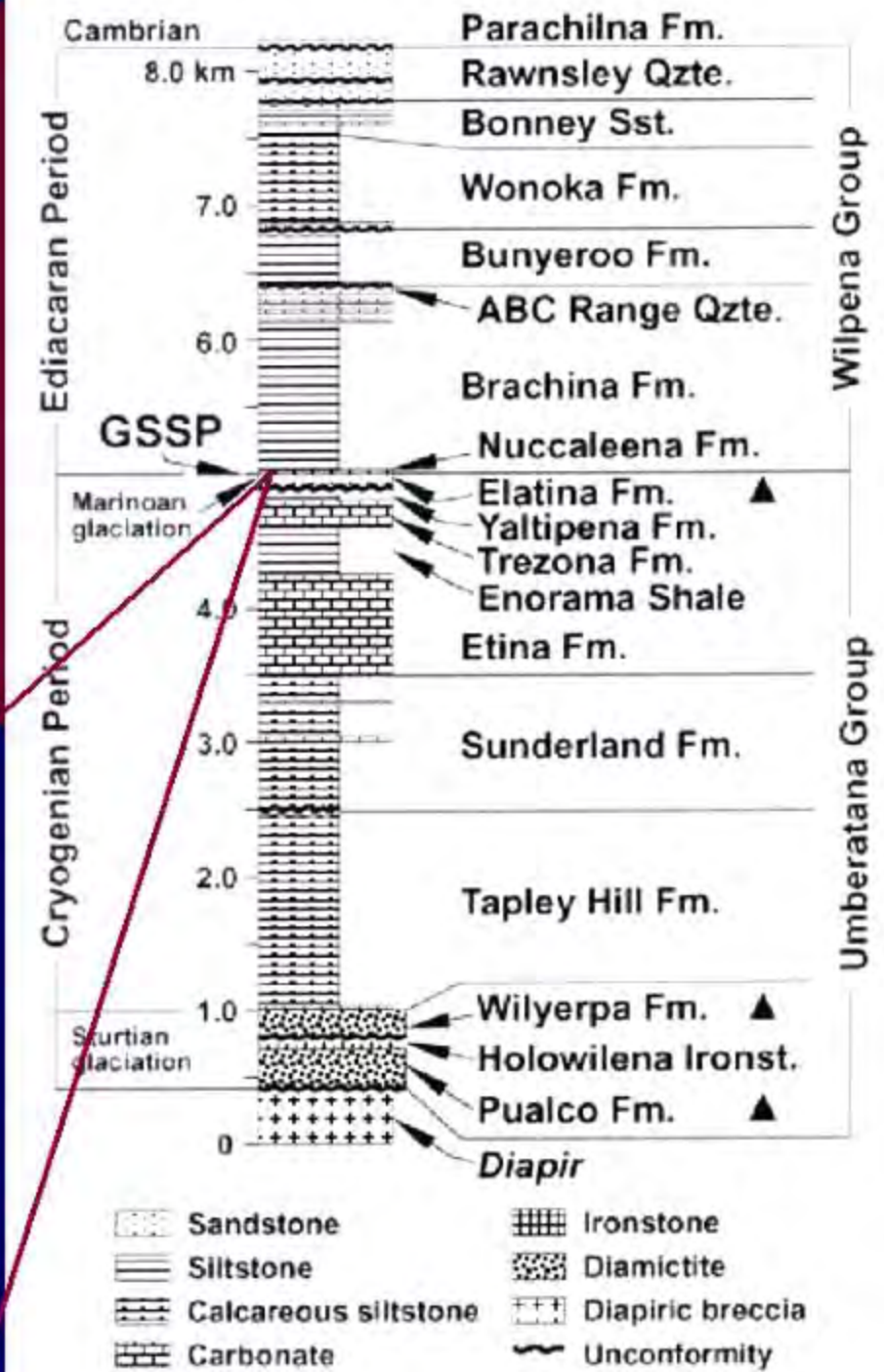
帽碳酸盐岩

冰碛岩

关键是中国冰碛岩对哪几期（地层对比）

2004年是国际末前寒武纪年代地层学研究发生重要变革的时期。

2003年12月，国际地层委员会末元古系分会主席Knoll等在分会全体委员三轮投票的基础上，完成《埃迪卡拉纪作为地质年表一个新增时间单位》的报告，提交国际地层委员会。国际地层委员会于2004年2月16日以14票赞成，1票反对，1票弃权的结果通过了上述报告。



陡山沱组
“盖帽碳酸盐岩”

Ediacaran系底界

秭归

2008 7 3



九龙湾



7.2.2.3
DT

2.3d

SPRINGER
Geological Survey
No. 1000
2010.10

樟村坪

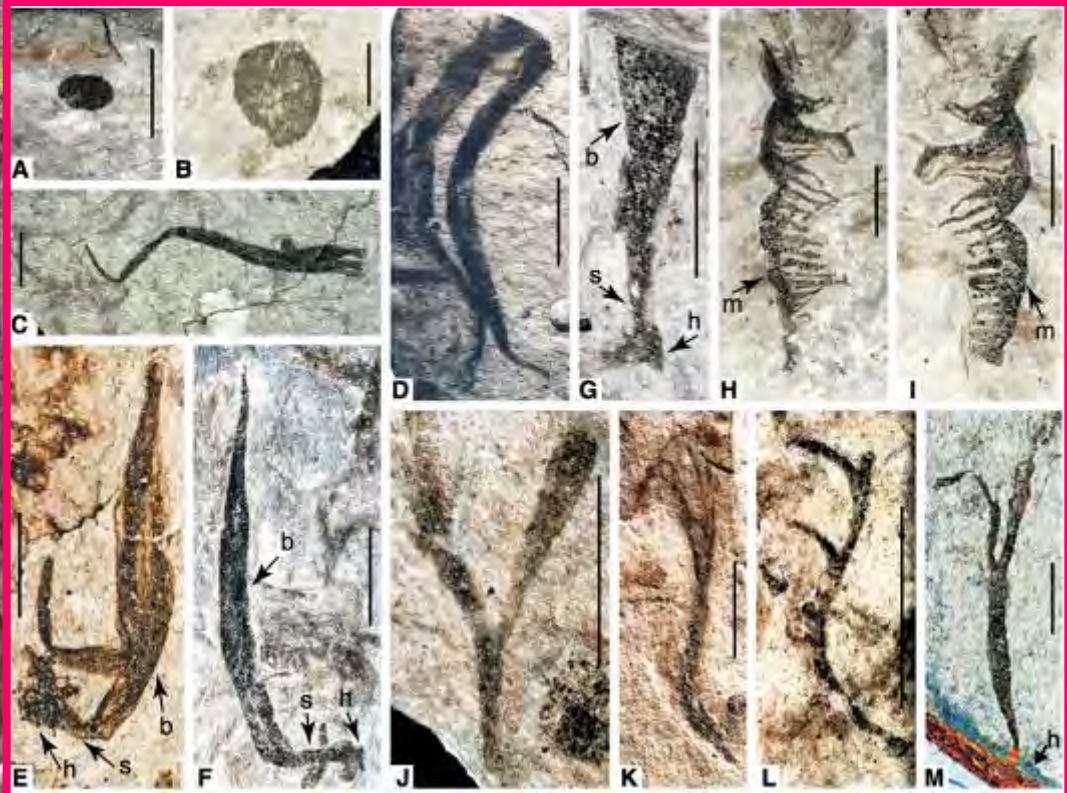


神农架



宋洛







中国地质大学
China University of Geosciences

澳大利亚悉尼盆地二叠系

2015年8月野外考察



































秭归教学实习基地

将成为地学人才培养的“金钉子”

谢谢聆听

2010/06/28