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Supplemental Material

Supplemental Text S1. Chronostratigraphy of the middle and upper Cambrian, Paleogeographic and paleoenvironmental background for the SPICE sections, and Methods.

Figure S1. Correlation of trilobite zones between South China and Laurentia.

Figure S2. Evaluation of diagenesis in the Wangcun and Duibian sections.

Figure S3. Crossplots of U_{EF} vs. Al, Mo_{EF} vs. Al, P_2O_5 vs. Fe_2O_3, P_2O_5 vs. TOC and P_2O_5 vs. CaO for the Wangcun and Duibian sections.

Table S1. Summary of SPICE sections with paired $\delta^{13}C$ and $\delta^{34}S$ data.

Table S2. Geochemical data of Wangcun, Duibian A and Duibian B sections.

Supplementary Information

Environmental and trilobite diversity changes during the late Cambrian SPICE event

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Supplemental Text S1

1. Chronostratigraphy of the middle and upper Cambrian

The study interval spans portions of the middle Cambrian Miaolingian Series (= Series 3) and the upper Cambrian Furongian Series. The Miaolingian is composed of the Wuliuan (= Stage 5), Drumian, and Guzhangian stages, and the Furongian of the Paibian, Jiangshanian, and Stage 10 stages, in chronological order (Walker et al., 2018). The Drumian-Guzhangian stage boundary (~500.5 Ma), the Guzhangian-Paibian stage boundary (~497 Ma; = Miaolingian-Furongian series boundary) and the Paibian-Jiangshanian stage boundary (~494 Ma) are formally defined based on the FADs of the trilobite taxa *L. laevigata*, *G. reticulatus* and *Ag. orientalis*, respectively (Peng et al., 2004, 2009, 2012). The Drumian, Guzhangian, Paibian, and Jiangshanian stages are not formally subdivided into early/middle/late parts, but an informal subdivision exists in the study area. The *P. aculeatus*, *P. punctuosus*, and *Go. nathorsti* to *L. armata* trilobite zones are regarded as middle to late Drumian, and the *L. laevigata*, *Pr. bulbus*, and *Li. reconditus* to *G. stolidotus* trilobite zones as early to late Guzhangian, and the *G. reticulatus*, *A. inexpectans* and *T. orientalis* trilobite zones as early, middle, and late Paibian, respectively. The peak of the SPICE is located within the *A. inexpectans* Zone. The *Ag. orientalis* and *Eolotagnostus* trilobite zones correspond to the early and late Jiangshanian stages, respectively.

2. Paleogeographic and paleoenvironmental background for the SPICE sections

The study sections consist dominantly of limestone with interbedded shale, consistent with deposition on the Jiangnan Slope. At Wangcun, the SPICE is present within the Huaqiao Formation, which is composed of dark grey conglomeratic limestone and oolitic limestone, with horizontal and hummocky lamination, indicative of low-energy depositional environments below fair-weather wavebase in an upper slope setting (Zhou et al., 2012). At Duibian, the SPICE is present within the Huayansi Formation, which consists mainly of dark, medium-bedded (~5-10 cm) limestone with

thin (<0.5 cm) shale interbeds (Fig. 2). Duibian contains more marl than Wangcun, suggesting relatively greater water depth, e.g., a lower slope setting (Li et al., 2018; Zuo, et al., 2018). Water depths on late Cambrian platform/shelf margins (e.g., the Jiangnan Slope) are not well known, but assuming a morphological similarity to the Miocene-Quaternary Great Bahama Bank, may have been in the hundreds of meters (cf. Kenter, 1990). We tentatively estimate depositional water depths as ~100-200 m at Wangcun and ~200-300 m at Duibian.

For interregional comparisons, we chose the Andrarum no. 3 core of Sweden (Gill et al., 2011) as a key section. In this core, which is located on the northern margin of the Early Paleozoic Baltic Craton, the SPICE interval is composed mainly of black shale (i.e., Alum Shale) with bituminous carbonate and abundant pyrite present as fine disseminations, distinct nodules, and blebs (Gill et al., 2011). Pervasive laminations and an absence of sedimentary structures suggest deposition below storm wavebase on a broad, shallow, sloping shelf (Andersson et al., 1985), at water depths tentatively estimated at ~300-400 m.

We also compiled paired carbon-sulfur isotope data for four additional sections (i.e., Shingle Pass, Lawson Cove, TE-1 Texas County Core, Mount Whelan Core). During the late Cambrian, Shingle Pass and Lawson Cove were located on the northern margin of the Laurentia, the TE-1 Texas County Core on the western margin of the Laurentia, and the Mount Whelan Core on the northwestern margin of Gondwana. Trilobite biostratigraphic correlations between the Laurentia and South China are given in Figure S1.

These sections represent a range of depositional settings from subtidal to deep basinal area (Table S1). First, in the Lawson Cove, the Paibian consists of shallow-marine facies (in ascending order): supratidal stromatolitic bindstones of the uppermost Big Horse Formation (Liley, 1976), shallow-shelf calcareous shale interbedded with flat pebble conglomerates, trilobite packstones and wackestones of the Steamboat Pass Member, and deeper-shelf wackestones and mudstones of the Sneakover Member (Liley, 1976; Hintze and Palmer, 1976; Hintze, 2003). Therefore, we infer that this section records overall deepening from the lower to upper part of the section, to maximum water depths of ~50-100 m, with deposition largely within the deeper subtidal zone. Biostratigraphically, the extinction of the Marjuman Biomere at Lawson Cove has been constrained to a six-meter interval in the upper Big Horse Limestone Member (Thomas, 1993). The Pterocephaliid Biomere has been recovered but lacks diagnostic fossils for biozonation (Hintze and Palmer, 1976).

Second, at Shingle Pass, the SPICE is present in the uppermost Emigrant Springs, Johns Walsh, Corset Spring and lower part of Whipple Cave formations, in ascending order (Saltzman et al., 1998). The Emigrant Springs Formation is composed of interbedded calcareous shales, wackestones and flat pebble conglomerates, representing deposition in subtidal environments with episodic storm scouring (Markello and Read, 1982). The Johns Walsh Formation consists of non-fossiliferous, cross-bedded, peloidal grainstones at its base, and peloidal grainstones, ooid grainstones, wackestones, flat pebble conglomerates and thrombolitic boundstones in its middle and upper parts, indicating deposition in subtidal to deeper areas (Liley, 1976; Markello and Read, 1982; Saltzman et al., 1998). The Corset Spring Formation consists of cycles of calcareous shale and oolitic

wackestone, with more abundant and thicker shale layers upwards, suggesting deepening from the lower to the upper part of the formation (Liley, 1976). The Whipple Cave Formation consists of massive beds of cherty wackestone, reflecting a deep subtidal environment below storm wavebase (Brady and Rowell, 1976). Therefore, the main part of the SPICE interval of the section was deposited in subtidal to deeper shelf settings, possibly at water depths of ~100-200 m. Specimens of the trilobite *Coosella perplexa* were identified and defined the horizon of the end-Marjuman Biomere extinction in the uppermost Emigrant Springs Formation (Thomas, 1993).

Third, at Mount Whelan, only the lower and middle Paibian are preserved in the Georgina Limestone, which was deposited in a tropical setting on the outer shelf of Gondwana. The Georgina Limestone consists mostly of medium-grey argillaceous micritic limestone, with regular millimeter-scale lamination and a general lack of current-produced structures, and occasional upward-fining units of turbiditic deposition, indicative of deposition below storm wavebase (Green and Balfe, 1980), possibly at water depths of ~200-300 m. *Glyptagnostus reticulatus* and *Irvingella tropica* have been identified in the rising and falling limbs of the SPICE, respectively (Green and Balfe, 1980).

Finally, in the TE-1 Texas County Core, the Paibian is recorded by calcareous quartz siltstone containing minor skeletal packstone and wackestone beds in the Sullivan Siltstone Member of the lower Bonneterre Formation, glauconitic skeletal packstone and wackestone beds with interbedded green and black shale in the Whetstone Creek Member of the upper Bonneterre Formation, and similar lithologies in the overlying lower Davis Formation. These facies are indicative of a deep basinal setting (Palmer, 1989), possibly having water depths of ~600-800 m. Trilobites and brachiopods have been identified from the *Elvinia* Zone, along with others from Pterocephaliid Biomere zones (Kurtz, 1989).

3. Methods

3.1. Elemental analysis

The measurement of major and trace element concentrations was carried out in the State Key Laboratory of Geological Processes and Mineral Resources (SKL-GPMR) at the China University of Geosciences–Wuhan. PANalytical Zetium X-ray fluorescence was used to analyze major element content. Powder samples are fused into glass at high temperature before analysis. Element content is measured using wavelength dispersion method. Average analytical uncertainty is better than 5% (RSD) based on repeated analysis of national standards GBW07132, GBW07133 and GBW07407.

About 50 mg of each sample powder was weighed into a Teflon bomb, and 1 mL HNO_3 and 1 mL HF were added before heating for ~48 h at 190 °C in the sealed bomb. After cooling, the contents of the bomb were evaporated at 115 °C to incipient dryness, and 1 mL HNO_3 and 1 mL 1-ppm indium (In) laboratory standard were added. The bomb was then resealed and heated to 190 °C for another 12 h. The final solution was transferred to a polyethylene bottle and diluted in 2 % HNO_3 to about 100 mL for ICP-MS analysis. An Agilent 7500a ICP-MS was used to analyze trace element

(e.g., Mo, U, Ce and Sr) concentrations. Results were calibrated using the international standards AGV-2, BHVO-2, BCR-2 and GSR-1 with an average analytical uncertainty better than 2% (RSD).

3.2. Total organic carbon content

About 10 g of powdered sample were digested using 6 M HCl in order to remove any carbonate minerals. The residue was then centrifuged, dried and ground for analysis. Total organic carbon (TOC) analyses were conducted using an Elementar Vario microcube analyzer. Data reliability was assessed through measurement of a standard sample DP-1 (TOC = 65.44%). Both a standard sample and a repeat were analyzed after every 12 unknowns, yielding an analytical precision of 2.5% of the reported values.

3.3. Carbonate carbon isotope analysis

In preparation for carbonate carbon-isotopic analysis, ~60–80 μg of powder were placed in a 10 mL Na-glass vial, sealed with a butyl rubber septum, and reacted with 100% phosphoric acid at 70 °C after flushing with helium. The evolved CO_2 gas was analyzed for $\delta^{13}C_{carb}$ and $\delta^{18}O_{carb}$ using a 253 plus mass spectrometer in SKL-GPMR. Isotope values are reported as per mille variation (‰) relative to Vienna Pee Dee belemnite (VPDB) standard. The analytical precision was better than 0.04‰ for $\delta^{13}C_{carb}$ and $\delta^{18}O_{carb}$ based on duplicate analyses of the national standard GBW-04416 ($\delta^{13}C_{carb}$ = +1.61‰; $\delta^{18}O_{carb}$ = −11.59‰) and GBW-04417 ($\delta^{13}C_{carb}$ = −6.06‰; $\delta^{18}O_{carb}$ = −24.12‰).

3.4. CAS-sulfur isotope analysis

About 50 g of powder were leached in a 10 % NaCl solution and rinsed in deionized water until all soluble sulfates were removed. The residual powder was then dissolved in 3-N HCl in order to release sulfur in the carbonate crystal lattice. The acidified samples were filtered, and an excess of 1 M $BaCl_2$ was added to the filtrate to precipitate $BaSO_4$. The $BaSO_4$ precipitate was then rinsed, filtered and dried, and 0.37–0.40 mg $BaSO_4$ combined with an excess of V_2O_5 was placed in a tin cup. CAS-sulfur isotope compositions were analyzed using Delta V plus IRMS in the State Key Laboratory of Biogeology and Environmental Geology (SKL-BGEG) at the China University of Geosciences-Wuhan. CAS sulfur isotope values are reported as per mille variation (‰) relative to Vienna Canyon Diablo Troilite (VCDT). Analytical precisions were ±0.08 ‰, ±0.09 ‰ and ±0.20 ‰ (1σ) respectively, calculated from duplicate analyses of the international standards NBS 127 ($\delta^{34}S$ = +20.0 ‰), IAEA SO-5 ($\delta^{34}S$ = +0.5 ‰) and IAEA SO-6 ($\delta^{34}S$ = −34.1 ‰).

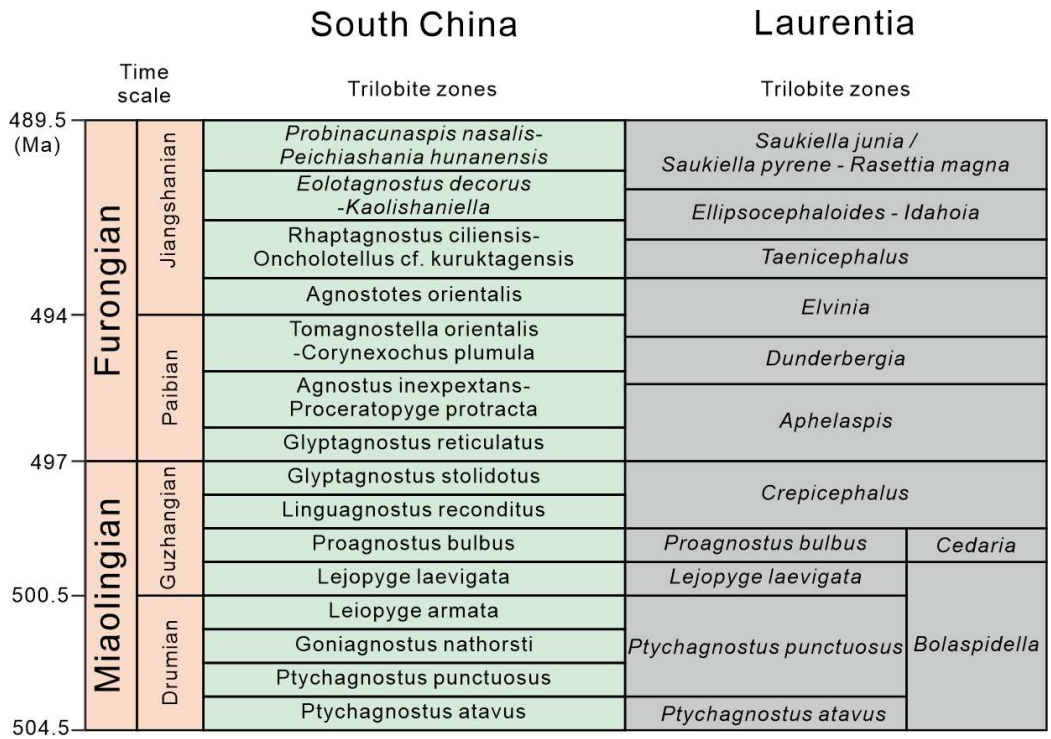

Fig. S1. Correlation of trilobite zones between South China and Laurentia (after Peng et al., 2020).

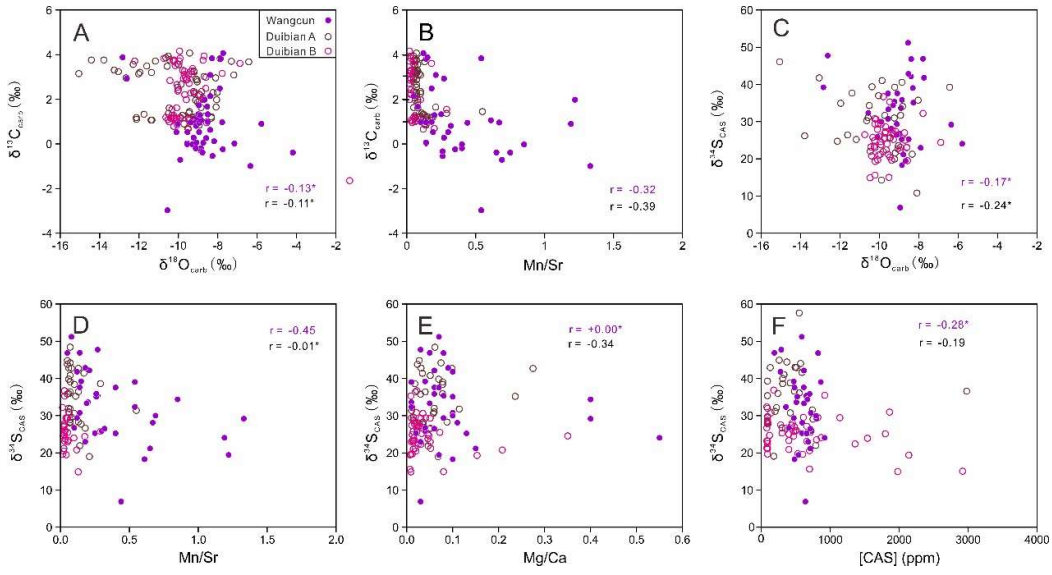

Fig. S2. Evaluation of diagenesis in the Wangcun and Duibian sections. (A) $\delta^{13}C_{carb}$ vs $\delta^{18}O_{carb}$; (B) $\delta^{13}C_{carb}$ vs Mn/Sr; (C) $\delta^{34}S_{CAS}$ vs $\delta^{18}O_{carb}$; (F) $\delta^{34}S_{CAS}$ vs Mn/Sr; (G) $\delta^{34}S_{CAS}$ vs Mg/Ca; (H) $\delta^{34}S_{CAS}$ vs [CAS]. The geochemical datasets of the Duibian A and B sections have been combined for purposes of statistical evaluation (black *r* values) owing to their proximity and general similarity. Asterisks represent correlation coefficients that are not statistically significant; others are significant at $p(\alpha) < 0.05$.

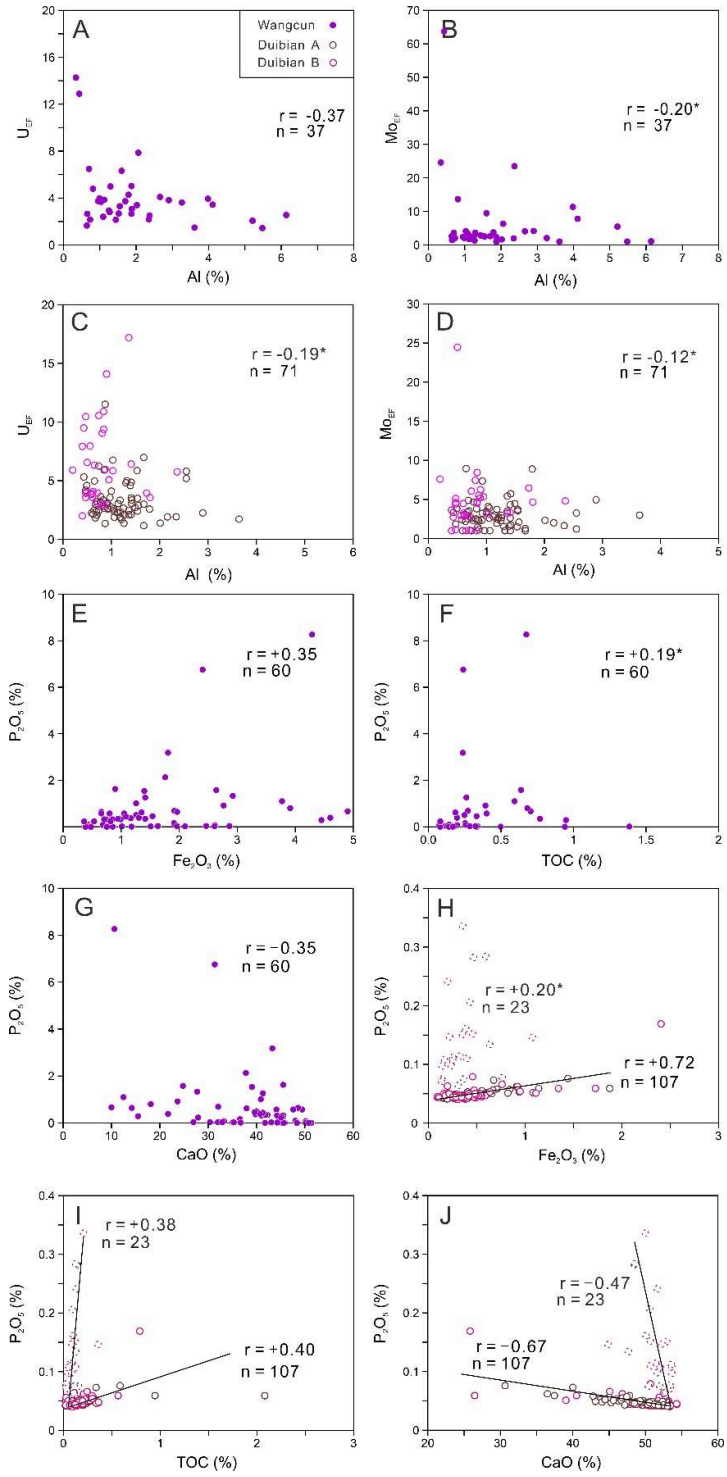

Fig. S3. Crossplots of U_{EF} vs. Al, Mo_{EF} vs. Al, P_2O_5 vs. Fe_2O_3, P_2O_5 vs. TOC and P_2O_5 vs. CaO for the Wangcun and Duibian sections. Asterisks represent correlation coefficients that are not statistically significant; others are significant at $p(\alpha) < 0.05$. In panels H-J, Duibian samples define two trends (shown with circles and dashed circles), and their correlation coefficients were calculated separately.

Table S1. Summary of SPICE sections with paired $\delta^{13}C$ and $\delta^{34}S$ data. Asterisks indicate lack of longitude and latitude coordinates in the original paper; for these sections, locations were estimated from maps in the referenced papers and the Google map coordinate system.

Sections	Locations	Longitude & latitude	Depositional setting	Facies description sources	Geochemical data sources
Lawson Cove	Utah, USA	38°41′26″N, 113°26′52″W	Deep subtidal zone	Liley, 1976; Hintze and Palmer, 1976; Hintze, 2003	$\delta^{13}C_{carb}$, $\delta^{34}S_{CAS}$ (Gill et al., 2011)
Shingle Pass	Nevada, USA	38°31′31″N, 114°57′6″W	Subtidal to deep shelf	Liley, 1976; Markello and Read, 1982; Saltzman et al., 1998	$\delta^{13}C_{carb}$ (Saltzman et al., 1998) $\delta^{34}S_{CAS}$ (Gill et al., 2007)
Wangcun	Hunan, China	28°43′2.84″ N, 109°58′ 26.10″ E	Upper slope	Peng et al., 2009; Zuo et al., 2018	$\delta^{13}C_{carb}$, $\delta^{34}S_{CAS}$ (this study)
Mount Whelan Core	Queensland, Australia	23°18′36″S, 138°52′36″E *	Below storm wave base	Green and Balfe, 1980	$\delta^{13}C_{carb}$ (Saltzman et al., 2000) $\delta^{34}S_{CAS}$, $\delta^{34}S_{pyrite}$ (Gill et al., 2011)
Duibian A	Zhejiang, China	28°48′48.38″N, 118°37′19.21″E	Lower slope	Zuo, 2006; Li et al., 2018	$\delta^{13}C_{carb}$, $\delta^{34}S_{CAS}$ (this study)
Duibian B	Zhejiang, China	28°48′46.14″ N, 118°37′17.20″ E			
Andrarum-3 drill core	Sweden	55°42′55.75″N, 13°58′41.25″E	Below storm wave base	Andersson et al., 1985 Gill et al., 2011	$\delta^{13}C_{org}$ (Ahlberg et al., 2008) $\delta^{34}S_{pyrite}$ (Gill et al., 2011)
TE-1 Texas County Core	Missouri, USA	37°28′53″N, 91°58′39″W	Deep basinal	Palmer, 1989	$\delta^{13}C_{carb}$, $\delta^{34}S_{CAS}$, $\delta^{34}S_{pyrite}$ (Gill et al., 2011)

References

Andersson, A., Dahlman, B., Gee, D.G., and Snäll, S., 1985, The Scandinavian alum shales: Sver. Geol. Undersök., v. 55, p. 1-50.

Brady, M.J., and Rowell, A.J., 1976, An Upper Cambrian subtidal blanket carbonate, eastern Great Basin: Brigham Young University Geology Studies, v. 23, p. 153-164.

Gill, B.C., Lyons, T.W., Young, S.A., Kump, L.R., Knoll, A.H., and Saltzman, M.R., 2011, Geochemical evidence for widespread euxinia in the later Cambrian ocean: Nature, v. 469, p. 80-83.

Green, P.M., and Balfe, P.E., 1980, Stratigraphic drilling report—GSQ Mt Whelan 1 and 2: Queensland Government Mining Journal, v. 81, p.162-178.

Hintze, L.F., 2003, Geology of Millard County, Utah: Utah Geological Survey Bulletin, v. 133, 305 p.

Hintze, L.F., and Palmer, A.R., 1976, Upper Cambrian Orr Formation: Its subdivisions and correlatives in Western Utah: United States Geological Survey Bulletin, v. 1405, 25 p.

Kenter, J.A., 1990, Carbonate platform flanks: slope angle and sediment fabric. Sedimentology, v. 37, p. 777–794.

Kurtz, V.E., 1989, in *Field Guide to the Upper Cambrian of Southeastern Missouri,* eds,. Gregg, J.M., Palmer, J.R. and Kurtz, V.E.: Department of Geology and Geophysics, University of Missouri-Rolla, Rolla, p.73-83.

Li, D.D., Zhang, X.L., Hu, D.P., Chen, X.Y., Huang, W., Zhang, X., Li, M.H., Qin, L.P., Peng, S.C., and Shen, Y.A, 2018, Evidence of a large $\delta^{13}C_{carb}$ and $\delta^{13}C_{org}$ depth gradient for deep-water anoxia during the late Cambrian SPICE event: Geology, v. 46, p.631-634.

Liley, W.W., 1976, Stratigraphy and paleoenvironments of the Pterocephaliid Biomere (Upper Cambrian) of Western Utah and Eastern Nevada [Ph.D. thesis]: Kansas, University of Kansas, Lawrence.

Markello, J.R., and Read, J.F., 1982, Upper Cambrian intrashelf basin, Nolichucky Formation, southwest Virginia Appalachians: AAPG Bulletin, v. 66, p. 860-878.

Palmer, J.R., 1989, Field Guide to the Upper Cambrian of Southeastern Missouri: Stratigraphy, Sedimentology and Economic Geology, eds., Gregg, J.M., Palmer, J.R., Kurtz, V.E., 24 p.

Peng, S.C., and Babcock, L.E., 2001, Cambrian of the Hunan–Guizhou Region, South China: Cambrian System of South China: Hefei, University of Science and Technology of China Press, 3-51 p.

Peng, S.C., and Robison, R.A., 2000, Agnostoid biostratigraphy across the Middle–Upper Cambrian boundary in Hunan, China: Journal of Paleontology, v. 74, p.1-104.

Peng, S.C., Babcock, L.E., and Cooper, R.A., 2012, The Cambrian Period, The Geologic Time Scale, v. 2, p. 437-488.

Peng, S.C., Babcock, L.E., Robison, R.A., Lin, H.L., Ress, M.N., and Saltzman, M.R., 2004, Global

standard stratotype-section and point (GSSP) of the Furongian Series and Paibian Stage (Cambrian): Lethaia, v. 37, p. 365-379.

Peng, S.C., Babcock, L.E., Zuo, J.X., Lin, H.L., and Chen, Y.A., 2009, The Global Boundary Stratotype Section and Point (GSSP) of the Guzhangian Stage (Cambrian) in the Wuling Mountains, Northwestern Hunan, China. Episodes, v. 32, p. 41–55.

Peng, S.C., Babcock, L.E., Ahlberg, P., 2020, The Cambrian Period: In Geologic Time Scale 2020 p. 565-629.

Pu, X.C., and Ye, H.Z., 1991, Cambrian sedimentary facies and palaeogeography framework in southern China: Collected Papers of Lithofacies and Paleogeography, v. 6, p. 1-16.

Saltzman, M.R., Runnegar, B., and Lohmann, K.C., 1998, Carbon isotope stratigraphy of Upper Cambrian (Steptoean Stage) sequences of the eastern Great Basin: Record of a global oceanographic event: Geological Society of America Bulletin, v. 110, p. 285-297.

Saltzman, M.R., Ripperdan, R.L., Brasier, M.D., Lohmann, K.C., Robison, R.A., Chang, W.T., Peng, S., Ergaliev, E.K., and Runnegar, B., 2000, A global carbon isotope excursion (SPICE) during the Late Cambrian: relation to trilobite extinctions, organic-matter burial and sea level: Palaeogeography, Palaeoclimatology, Palaeoecology, v. 162, p. 211-223.

Thomas, R.C., 1993, The Marjumiid-Pterocephaliid (Upper Cambrian) mass extinction event in the Western United States [Ph.D. thesis]: University of Washington, 352 p.

Walker, J.D., Geissman, J.W., Bowring, S.A., and Babcock, L.E., 2018, Geologic Time Scale v. 5.0: Geological Society of America.

Zhou, K.K., Mu, C.L., Wei, L., and Ge, X.Y., 2012, Is “Calciturbidites” the Cambrian Huaqiao Formation in the Wangcun arearea, northwestern Hunan. Acta Geologica Sinica, v. 86, p. 1143-1149.

Zuo, J., 2006, Characteristics of Carbon and Isotopic Composition of Cambrian Carbonates, South China: Nanjing: Postdoctoral Report of the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, 171 pp.

Zuo, J., Peng, S., Qi, Y., Zhu, X., Bagnoli, G., and Fang, H., 2018, Carbon-isotope excursions recorded in the Cambrian system, South China: Implications for mass extinctions and sea-level fluctuations. Journal of Earth Science, v. 29, p. 479–491.

Table S2. Geochemical data of Wangcun, Duibian A and Duibian B sections.

Subdivision	Interval	Formation	Stage	Height(m)	Sample No	$\delta^{13}C_{carb}$ (‰)	$\delta^{18}O_{carb}$ (‰)	$\delta^{34}S_{CAS}$ (‰)	[CAS] (ppm)	TOC (%)	P (%)	Al (%)	U (ppm)	Mo (ppm)	Mn/Sr	Mg/Ca	Corg/P	UEF	MoEF
Post-SPICE	V	Shenjiawan	Jiangshanian	619.0	WC-327	1.53	-9.06												
Post-SPICE	V	Shenjiawan	Jiangshanian	617.0	WC-326					0.12	0.014	1.52			0.21	0.18	21.8		
Post-SPICE	V	Shenjiawan	Jiangshanian	605.0	WC-320	1.00	-9.11	29.4	471.4		0.670	1.88	2.01	0.37	0.12	0.08		3.1	1.1
Post-SPICE	V	Shenjiawan	Jiangshanian	595.0	WC-315					0.25	0.070	1.19			0.24	0.06	9.3		
Post-SPICE	V	Shenjiawan	Jiangshanian	591.0	WC-313	0.89	-10.03												
Post-SPICE	V	Shenjiawan	Jiangshanian	579.0	WC-307					0.20	0.031	1.66			0.29	0.10	16.3		
Post-SPICE	V	Shenjiawan	Jiangshanian	577.0	WC-306	0.53	-10.10	25.9	731.4		0.440	1.87	1.73	0.35	0.30	0.04		2.7	1.0
Post-SPICE	V	Shenjiawan	Jiangshanian	563.0	WC-299	1.19	-9.09												
Post-SPICE	V	Shenjiawan	Jiangshanian	559.0	WC-297					0.17	0.010	0.59			0.31	0.06	42.6		
Post-SPICE	V	Shenjiawan	Jiangshanian	551.0	WC-293	0.98	-8.97	26.7	401.2		0.140	0.99	1.37	0.38	0.10	0.04		4.0	2.1
Post-SPICE	V	Shenjiawan	Jiangshanian	545.0	WC-290					0.32	0.008	1.14			0.16	0.12	99.6		
Post-SPICE	V	Shenjiawan	Jiangshanian	539.0	WC-287	0.63	-8.39												
Post-SPICE	V	Shenjiawan	Jiangshanian	531.0	WC-283					0.26	0.036	0.31			0.04	0.06	18.5		
Post-SPICE	V	Shenjiawan	Jiangshanian	527.0	WC-281	0.81	-9.11	26.5	710.5		0.930	2.02	2.39	0.62	0.32	0.06		3.4	1.6
Post-SPICE	V	Huaqiao	Jiangshanian	517.0	WC-276					0.70	0.292	5.22			0.66	0.43	6.2		

Post-SPICE	V	Huaqiao	Jiangshanian	515.0	WC-275	1.73	-8.96												
Post-SPICE	V	Huaqiao	Jiangshanian	510.0	WC-273					0.15									
Post-SPICE	V	Huaqiao	Jiangshanian	502.0	WC-269	1.33	-8.51	25.3	591.6	0.40	0.250	1.03	1.32	0.79	0.25	0.02	4.1	3.7	4.1
Post-SPICE	V	Huaqiao	Jiangshanian	496.0	WC-266					1.39		0.41			0.42	0.02			
Post-SPICE	V	Huaqiao	Jiangshanian	490.0	WC-263	1.33	-8.99												
Post-SPICE	V	Huaqiao	Jiangshanian	488.0	WC-262					0.15	0.014	1.54			0.27	0.07	27.6		
Post-SPICE	V	Huaqiao	Jiangshanian	480.0	WC-258	0.95	-8.94	6.9	639.9		0.250	0.64	0.37	0.31	0.44	0.03		1.7	2.6
Post-SPICE	V	Huaqiao	Jiangshanian	472.0	WC-254					0.08	0.034	0.24			0.13	0.02	5.7		
Post-SPICE	V	Huaqiao	Jiangshanian	470.0	WC-253	1.06	-8.85	18.3	481.5		0.580	3.61	1.86	0.37	0.61	0.10		1.5	1.0
Post-SPICE	V	Huaqiao	Jiangshanian	459.0	WC-249					0.34	0.011	1.65			0.24	0.07	80.1		
Post-SPICE	V	Huaqiao	Jiangshanian	455.0	WC-247	0.96	-9.39	28.1	593.6		0.170	5.48	2.75	0.75	0.67	0.11		1.4	1.0
Falling SPICE	IV	Huaqiao	Jiangshanian	449.0	WC-244					0.95	0.125	2.99			1.01	0.51	19.5		
Falling SPICE	IV	Huaqiao	Jiangshanian	443.0	WC-241	1.29	-8.90	33.6	508.8		0.280	0.70	1.58	0.47	0.20	0.01		6.5	3.6
Falling SPICE	IV	Huaqiao	Jiangshanian	439.0	WC-239														
Falling SPICE	IV	Huaqiao	Jiangshanian	431.0	WC-235	1.98	-8.67	19.4	539.4	0.64	0.690	2.35	1.79	0.86	1.22	0.07	2.4	2.2	2.0
Falling SPICE	IV	Huaqiao	Paibian	419.0	WC-229	2.49	-7.90	23.0	681.0		0.250	0.65	0.60	0.18	0.18	0.03		2.7	1.5

Falling SPICE	IV	Huaqiao	Paibian	413.0	WC-226					0.13	0.007	0.50			0.17	0.05	46.1		
Falling SPICE	IV	Huaqiao	Paibian	405.0	WC-222	3.09	-8.39	42.1	618.7	0.24	1.390	0.95	1.24	0.42	0.21	0.06	0.4	3.7	2.4
Falling SPICE	IV	Huaqiao	Paibian	397.0	WC-218					0.14	0.041	0.22			0.06	0.04	8.9		
Falling SPICE	IV	Huaqiao	Paibian	395.0	WC-217	3.81	-7.86				0.160	1.52	1.42	0.75	0.14	0.09		2.7	2.6
Falling SPICE	IV	Huaqiao	Paibian	385.0	WC-212	4.07	-7.73	41.8	278.1		0.140	1.25	1.28	0.61	0.12	0.10		2.9	2.6
Falling SPICE	IV	Huaqiao	Paibian	377.0	WC-208	3.88	-12.84	39.2	470.4		0.140	1.44	1.08	0.76	0.15	0.04		2.2	2.8
Falling SPICE	IV	Huaqiao	Paibian	369.0	WC-204					0.16		0.19			0.04	0.04			
Rising SPICE	III	Huaqiao	Paibian	361.0	WC-200	3.84	-8.30	39.0	862.7	0.77	0.150	0.81	1.35	2.06	0.54	0.01	13.2	4.8	13.6
Rising SPICE	III	Huaqiao	Paibian	356.0	WC-198					0.33		0.19			0.16	0.02			
Rising SPICE	III	Huaqiao	Paibian	349.0	WC-195														
Rising SPICE	III	Huaqiao	Paibian	345.0	WC-193	2.93	-12.62	47.7	289.3		0.150	1.27	1.24	0.31	0.27	0.03		2.8	1.3
Rising SPICE	III	Huaqiao	Paibian	335.0	WC-183					0.08		0.16			0.01	0.06			
Rising SPICE	III	Huaqiao	Paibian	317.0	WC-179					0.14		0.13			0.01	0.11			
Rising SPICE	III	Huaqiao	Paibian	315.0	WC-178	2.14	-8.38	46.8	823.7		0.100	0.73	0.55	0.28	0.05	0.08		2.2	2.1
Rising SPICE	III	Huaqiao	Paibian	303.0	WC-172					0.18	0.007	0.79			0.09	0.14	69.9		
Rising SPICE	III	Huaqiao	Paibian	299.0	WC-170	1.67	-8.54	51.2	587.3		0.140	1.09	0.91	0.67	0.08	0.07		2.4	3.3

Rising SPICE	III	Huaqiao	Paibian	293.0	WC-167				629.0	0.17		0.33			0.07	0.06			
Rising SPICE	III	Huaqiao	Paibian	285.0	WC-163	0.99	-8.52	42.8			0.190	1.55	1.78	0.72	0.18	0.09		3.3	2.5
Early SPICE	II	Huaqiao	Guzhangian	277.0	WC-159					0.94		0.18			0.15	0.02			
Early SPICE	II	Huaqiao	Guzhangian	273.0	WC-157	0.97	-7.78	46.9	189.7		0.710	1.12	1.50	0.36	0.14	0.05		3.8	1.7
Early SPICE	II	Huaqiao	Guzhangian	265.0	WC-153					0.28	0.012	1.29			0.26	0.12	60.1		
Early SPICE	II	Huaqiao	Guzhangian	261.0	WC-151	0.53	-9.54	33.3	620.0		0.190	1.70	2.21	0.83	0.19	0.05		3.7	2.6
Early SPICE	II	Huaqiao	Guzhangian	245.0	WC-143	0.28	-9.23	35.3	651.7	0.24	2.950	2.90	3.86	2.25	0.27	0.08	0.2	3.8	4.2
Early SPICE	II	Huaqiao	Guzhangian	229.0	WC-135	-0.02	-9.30	34.4	670.1	0.67	3.610	6.14	5.45	1.24	0.85	0.40	0.5	2.5	1.1
Pre-SPICE	Ib	Huaqiao	Guzhangian	215.0	WC-128	-0.19	-8.86	25.2	657.9	0.50	1.580	3.26	4.11	1.24	0.40	0.13	0.8	3.6	2.0
Pre-SPICE	Ib	Huaqiao	Guzhangian	201.0	WC-121	0.05	-8.74												
Pre-SPICE	Ib	Huaqiao	Guzhangian	195.0	WC-118					0.33	0.014	1.72			0.17	0.23	60.1		
Pre-SPICE	Ib	Huaqiao	Guzhangian	189.0	WC-115	0.03	-9.56	30.8	718.6	0.27	0.300	2.66	3.79	2.02	0.14	0.10	2.3	4.1	4.1
Pre-SPICE	Ib	Huaqiao	Guzhangian	173.0	WC-107	0.26	-8.59												
Pre-SPICE	Ib	Huaqiao	Guzhangian	166.5	WC-100	0.06	-9.09	37.6	616.0	0.25	0.220	1.79	2.67	1.25	0.14	0.06	2.9	4.3	3.7
Pre-SPICE	Ib	Huaqiao	Guzhangian	163.5	WC-94	0.12	-8.19												
Pre-SPICE	Ib	Huaqiao	Guzhangian	160.0	WC-87	-0.54	-8.27	35.1	521.9	0.20	0.170	1.29	2.24	0.88	0.26	0.10	3.0	5.0	3.7

Pre-SPICE	Ib	Huaqiao	Guzhangian	156.0	WC-79	0.53	-8.95												
Pre-SPICE	Ib	Huaqiao	Guzhangian	144.0	WC-73	-0.33	-8.85	35.9	701.7	0.26	0.550	1.87	3.27	0.82	0.26	0.06	1.2	5.0	2.4
Pre-SPICE	Ib	Huaqiao	Guzhangian	132.0	WC-67	-0.20	-9.12												
Pre-SPICE	Ib	Huaqiao	Guzhangian	118.0	WC-60	-0.38	-8.78	21.2	712.0	0.39	0.400	3.98	5.46	8.41	0.65	0.15	2.5	3.9	11.3
Pre-SPICE	Ib	Huaqiao	Guzhangian	102.0	WC-52	0.02	-7.16												
Pre-SPICE	Ib	Huaqiao	Guzhangian	96.0	WC-49					0.29									
Pre-SPICE	Ib	Huaqiao	Guzhangian	86.0	WC-44	-0.01	-9.56	37.6	482.4	0.33	0.200	2.06	5.64	2.43	0.40	0.07	4.3	7.9	6.3
Pre-SPICE	Ib	Huaqiao	Guzhangian	70.0	WC-36	0.90	-5.79	24.0	919.5	0.59	0.480	5.21	3.76	5.31	1.19	0.55	3.2	2.1	5.5
DICE	Ia	Huaqiao	Guzhangian	56.0	WC-29	-0.99	-6.35	29.2	800.2	0.68	0.350	4.11	4.93	5.99	1.33	0.40	5.0	3.4	7.8
DICE	Ia	Huaqiao	Guzhangian	44.0	WC-23	-0.71	-9.91	30.0	794.3	0.19	0.270	1.60	3.52	2.82	0.69	0.10	1.8	6.3	9.4
DICE	Ia	Huaqiao	Drumian	30.0	WC-16	-2.97	-10.56	32.3	357.2	0.08	0.100	0.34	1.69	1.56	0.54	0.01	2.1	14.3	24.6
DICE	Ia	Aoxi	Drumian	18.0	WC-10	-0.39	-4.19				0.280	2.37	2.06	10.40	0.75	0.60		2.5	23.5
DICE	Ia	Aoxi	Drumian	4.0	WC-3	-0.24	-7.75				0.100	0.43	1.93	5.11	0.35	0.63		12.9	63.7

Subdivision	Interval	Formation	Stage	Height(m)	Sample No	$\delta^{13}C_{carb}$ (‰)	$\delta^{18}O_{carb}$ (‰)	$\delta^{34}S_{CAS}$ (‰)	[CAS] (ppm)	TOC (%)	P (%)	Al (%)	U (ppm)	Mo (ppm)	Mn/Sr	Mg/Ca	Corg/P	UEF	MoEF
Falling SPICE	IV	Huayansi	Paibian	78.5	DBA-12	1.19	-9.89	21.9	786.4	0.22	0.023	2.55	5.14	1.55	0.14	0.05	24.8	5.8	3.3
Falling SPICE	IV	Huayansi	Paibian	76.5	DBA-13	0.66	-9.51			0.11	0.028	0.87	3.47	0.36	0.12	0.01	10.2	11.5	2.2
Falling SPICE	IV	Huayansi	Paibian	74.5	DBA-14	1.65	-8.09	19.0	177.3	0.22	0.023	2.55	4.62	0.58	0.21	0.07	24.8	5.2	1.2
Falling SPICE	IV	Huayansi	Paibian	72.5	DBA-15	1.98	-8.06			0.06	0.049	0.59	0.46	0.09	0.08	0.01	3.0	2.2	1.0
Falling SPICE	IV	Huayansi	Paibian	70.5	DBA-16	1.87	-9.03	29.6	88.1	0.05	0.020	1.06	0.69	0.07	0.08	0.01	6.6	1.9	1.0
Falling SPICE	IV	Huayansi	Paibian	68.5	DBA-17	2.26	-9.20			0.02	0.018	0.87	0.41	0.19	0.10	0.01	2.9	1.4	1.2
Falling SPICE	IV	Huayansi	Paibian	66.5	DBA-18	2.35	-9.24	35.8	243.0	0.13	0.021	1.03	2.43	0.79	0.05	0.03	16.3	6.7	4.1
Falling SPICE	IV	Huayansi	Paibian	64.5	DBA-19	2.78	-9.05			0.16	0.033	1.30	2.18	0.37	0.05	0.03	12.2	4.8	1.5
Falling SPICE	IV	Huayansi	Paibian	63.3	DBA-20	2.87	-9.06	28.9	749.6	0.36	0.021	1.54	1.87	1.01	0.07	0.01	45.4	3.5	3.5
Falling SPICE	IV	Huayansi	Paibian	61.3	DBA-21	3.02	-8.70			0.11	0.018	0.77	0.86	0.33	0.06	0.02	14.9	3.2	2.3
Falling SPICE	IV	Huayansi	Paibian	59.3	DBA-22	2.96	-8.11			0.11	0.033	0.47	0.68	0.16	0.05	0.03	8.7	4.2	1.8
Falling SPICE	IV	Huayansi	Paibian	57.3	DBA-23	3.23	-9.20			0.17	0.021	1.18	1.37	0.82	0.06	0.03	21.7	3.3	3.7
Falling SPICE	IV	Huayansi	Paibian	56.3	DBA-24	3.27	-9.22	42.7	132.9	0.34	0.032	1.41	2.39	0.69	0.08	0.10	27.3	4.9	2.6
Falling SPICE	IV	Huayansi	Paibian	54.3	DBA-25	3.82	-7.88			0.09	0.018	0.43	0.80	0.27	0.06	0.03	13.1	5.3	3.3
Falling SPICE	IV	Huayansi	Paibian	52.8	DBA-26	3.71	-11.17	31.0	199.5	0.12	0.021	0.92	0.99	0.40	0.06	0.06	14.8	3.1	2.3

Falling SPICE	IV	Huayansi	Paibian	51.3	DBA-27	3.56	-12.30			0.20	0.021	1.18	0.78	0.43	0.08	0.14	24.8	1.9	2.0
Falling SPICE	IV	Huayansi	Paibian	49.8	DBA-28	3.76	-13.79	31.8	88.7	0.16	0.021	1.05	0.95	0.51	0.07	0.11	20.3	2.6	2.6
Falling SPICE	IV	Huayansi	Paibian	48.3	DBA-29	3.76	-14.42			0.13	0.019	1.00	1.43	0.64	0.06	0.03	17.6	4.1	3.4
Falling SPICE	IV	Huayansi	Paibian	46.8	DBA-30	3.77	-10.46	28.3	87.8	0.18	0.019	0.69	0.78	0.63	0.07	0.09	23.7	3.2	4.9
Falling SPICE	IV	Huayansi	Paibian	45.3	DBA-31	4.07	-9.43			0.10	0.018	0.64	0.55	0.26	0.07	0.04	13.9	2.5	2.2
Falling SPICE	IV	Huayansi	Paibian	43.8	DBA-32	3.49	-11.61	32.0	220.1	0.17	0.022	1.42	1.51	1.52	0.06	0.06	19.4	3.0	5.7
Falling SPICE	IV	Huayansi	Paibian	42.3	DBA-33	3.93	-10.52			0.21	0.019	0.65	1.12	1.08	0.05	0.05	28.3	5.0	8.9
Falling SPICE	IV	Huayansi	Paibian	40.8	DBA-34	3.86	-10.64	35.2	88.1	0.21	0.027	2.01	0.97	0.87	0.11	0.24	19.8	1.4	2.3
Falling SPICE	IV	Huayansi	Paibian	39.3	DBA-35	3.14	-12.02			0.23	0.025	2.16	1.44	0.81	0.09	0.15	23.2	1.9	2.0
Falling SPICE	IV	Huayansi	Paibian	38	DBA-36	3.21	-11.96	39.1	88.0	0.17	0.023	1.26	0.92	0.63	0.07	0.08	18.6	2.1	2.7
Falling SPICE	IV	Huayansi	Paibian	36.5	DBA-37	2.96	-12.66			0.19	0.020	0.78	0.99	0.68	0.05	0.03	25.5	3.6	4.7
Falling SPICE	IV	Huayansi	Paibian	35	DBA-38	3.24	-13.05	44.8	263.3	0.14	0.022	0.69	0.57	0.32	0.05	0.03	17.1	2.4	2.5
Falling SPICE	IV	Huayansi	Paibian	33.5	DBA-39	3.55	-9.98			0.24	0.020	1.26	0.60	0.70	0.06	0.03	30.7	1.4	3.0
Falling SPICE	IV	Huayansi	Paibian	32	DBA-40	3.48	-10.57	35.9	552.2	0.18	0.021	1.21	0.71	0.60	0.06	0.08	21.8	1.7	2.7
Falling SPICE	IV	Huayansi	Paibian	30.5	DBA-41	3.20	-11.37			0.19	0.021	1.14	1.21	0.64	0.07	0.04	24.2	3.0	3.0
Rising SPICE	III	Huayansi	Paibian	29	DBA-42	3.15	-15.06	48.4	549.9	0.23	0.021	1.49	1.40	1.24	0.07	0.06	28.9	2.7	4.5

Rising SPICE	III	Huayansi	Paibian	27.5	DBA-43	3.31	-13.26			0.28	0.022	1.36	1.17	1.38	0.07	0.06	33.3	2.5	5.4
Rising SPICE	III	Huayansi	Paibian	26	DBA-44	2.67	-9.86	44.2	368.8	0.23	0.022	1.54	1.29	1.06	0.07	0.07	27.0	2.4	3.7
Rising SPICE	III	Huayansi	Paibian	24.5	DBA-45	3.70	-7.31			0.11	0.019	0.74	0.63	0.36	0.05	0.02	15.4	2.4	2.6
Rising SPICE	III	Huayansi	Paibian	23	DBA-46	3.68	-6.43	42.7	508.1	0.59	0.033	3.64	2.18	2.03	0.13	0.27	45.6	1.7	3.0
Rising SPICE	III	Huayansi	Paibian	21.5	DBA-47	2.91	-9.12			0.34	0.020	0.93	0.84	1.28	0.05	0.03	43.7	2.6	7.3
Rising SPICE	III	Huayansi	Paibian	20	DBA-48	2.54	-10.04	40.8	331.9	0.31	0.024	1.41	1.04	1.14	0.07	0.05	33.8	2.1	4.3
Rising SPICE	III	Huayansi	Paibian	19	DBA-49	2.06	-8.76			0.19	0.019	0.89	0.94	0.86	0.06	0.08	26.4	3.0	5.2
Rising SPICE	III	Huayansi	Paibian	17.5	DBA-50	2.35	-8.82	38.4	309.7	0.12	0.024	1.67	0.68	0.40	0.10	0.08	12.8	1.2	1.3
Rising SPICE	III	Huayansi	Paibian	16.5	DBA-51	3.09	-7.19			0.23	0.023	1.36	1.00	0.89	0.10	0.09	26.0	2.1	3.5
Rising SPICE	III	Huayansi	Paibian	14.5	DBA-52	2.19	-8.92	36.4	2975.4	2.08	0.026	1.79	1.60	2.97	0.07	0.04	208.6	2.6	8.9
Rising SPICE	III	Huayansi	Paibian	13.5	DBA-53	2.30	-8.25			0.15	0.020	0.67	0.43	0.37	0.07	0.05	19.9	1.8	2.9
Rising SPICE	III	Huayansi	Paibian	12.5	DBA-54	2.31	-8.03	39.8	310.4	0.20	0.019	0.62	0.46	0.35	0.06	0.07	26.9	2.1	3.0
Rising SPICE	III	Huayansi	Paibian	11.5	DBA-55	1.96	-9.13			0.16	0.021	0.70	0.50	0.46	0.06	0.06	20.6	2.1	3.5
Rising SPICE	III	Huayansi		10.5	DBA-56	1.63	-8.85	43.8	571.3	0.21	0.021	1.00	0.95	0.61	0.05	0.02	25.0	2.7	3.3
Rising SPICE	III	Huayansi		9.5	DBA-57	1.61	-10.47			0.20	0.021	1.05	0.89	0.76	0.08	0.05	24.7	2.4	3.9
Rising SPICE	III	Huayansi	Guzhangian	8	DBA-58	1.33	-11.75			0.95	0.026	2.89	2.26	2.67	0.12	0.03	94.8	2.2	5.0

Rising SPICE	III	Huayansi	Guzhangian	7	DBA-59	1.38	-9.47			0.21	0.021	1.19	0.96	0.55	0.11	0.05	25.7	2.3	2.5
Early SPICE	II	Huayansi	Guzhangian	6	DBA-60	1.16	-10.37	42.8	485.1	0.19	0.019	1.12	0.89	0.58	0.06	0.03	26.1	2.3	2.8
Early SPICE	II	Huayansi	Guzhangian	5	DBA-61	1.18	-12.14			0.17	0.021	1.25	1.15	0.53	0.08	0.04	21.2	2.6	2.3
Early SPICE	II	Huayansi	Guzhangian	4	DBA-62	1.10	-12.13	30.6	417.9	0.23	0.025	2.34	1.56	0.72	0.10	0.06	23.4	1.9	1.7
Early SPICE	II	Huayansi	Guzhangian	3	DBA-63	1.28	-10.34			0.13	0.019	0.67	0.70	0.42	0.06	0.02	17.2	3.0	3.4
Early SPICE	II	Huayansi	Guzhangian	2	DBA-64	1.37	-10.51	38.6	417.4	0.09	0.090	1.32	2.30	0.06	0.29	0.02	2.6	5.0	1.0
Early SPICE	II	Huayansi	Guzhangian	1	DBA-65	1.07	-11.35			0.10	0.021	0.93	0.86	0.56	0.12	0.03	12.0	2.6	3.2
Early SPICE	II	Huayansi	Guzhangian	0	DBA-66	1.07	-11.39	41.4	585.0	0.14	0.123	1.53	3.13	0.43	0.17	0.03	2.9	5.9	1.5
Early SPICE	II	Yangliuqing	Guzhangian	-1	DBA-67	1.18	-9.47			0.13	0.021	1.67	1.75	0.24	0.12	0.04	15.7	3.0	1.0
Early SPICE	II	Yangliuqing	Guzhangian	-2	DBA-68	0.90	-9.72	36.4	483.1	0.11	0.021	0.83	0.97	0.59	0.13	0.02	13.2	3.4	3.8
Early SPICE	II	Yangliuqing	Guzhangian	-3	DBA-69	0.99	-9.05			0.13	0.018	0.58	0.77	0.26	0.06	0.01	17.7	3.8	2.4
Pre-SPICE	Ib	Yangliuqing	Guzhangian	-4	DBA-70	1.05	-9.19	28.0	88.5	0.15	0.019	0.85	0.78	0.38	0.07	0.03	20.5	2.6	2.4
Pre-SPICE	Ib	Yangliuqing	Guzhangian	-5	DBA-71	1.21	-9.12			0.12	0.019	0.82	0.80	0.38	0.06	0.02	16.1	2.8	2.5
Pre-SPICE	Ib	Yangliuqing	Guzhangian	-6	DBA-72	1.45	-9.44	31.4	745.0	0.02	0.034	0.49	0.78	0.35	0.55	0.01	1.8	4.6	3.8
Pre-SPICE	Ib	Yangliuqing	Guzhangian	-7	DBA-73	1.23	-8.68			0.07	0.018	0.85	1.74	0.23	0.10	0.02	10.5	5.9	1.5
Pre-SPICE	Ib	Yangliuqing	Guzhangian	-8	DBA-74	1.28	-9.80	28.3	88.1	0.10	0.070	0.97	1.21	0.08	0.13	0.04	3.9	3.6	1.0

Pre-SPICE	Ib	Yangliuga ng	Guzhangi an	-9	DBA-75	1.05	-9.00			0.11	0.020	1.39	2.21	0.41	0.15	0.04	13.8	4.6	1.6
Pre-SPICE	Ib	Yangliuga ng	Guzhangi an	-10	DBA-76	1.22	-8.33	27.7	88.0	0.11	0.022	1.42	1.65	0.46	0.15	0.04	12.6	3.3	1.7
Pre-SPICE	Ib	Yangliuga ng	Guzhangi an	-11	DBA-77	1.16	-8.32			0.06	0.018	0.74	1.61	0.09	0.11	0.01	8.1	6.2	1.0
Pre-SPICE	Ib	Yangliuga ng	Guzhangi an	-12	DBA-78	1.19	-9.23	26.6	303.8	0.13	0.059	1.41	1.73	0.18	0.18	0.05	5.6	3.5	1.0
Pre-SPICE	Ib	Yangliuga ng	Guzhangi an	-13	DBA-79	1.20	-9.00			0.12	0.124	1.67	4.05	0.26	0.19	0.03	2.6	7.0	1.0
Pre-SPICE	Ib	Yangliuga ng	Guzhangi an	-14.5	DBA-80	0.84	-8.95			0.16	0.022	1.56	1.57	0.61	0.14	0.07	18.5	2.9	2.1

Subdivision	Interval	Formation	Stage	Height(m)	Sample No	$\delta^{13}C_{carb}$ (‰)	$\delta^{18}O_{carb}$ (‰)	$\delta^{34}S_{CAS}$ (‰)	[CAS] (ppm)	TOC (%)	P (%)	Al (%)	U (ppm)	Mo (ppm)	Mn/Sr	Mg/Ca	Corg/P	UEF	MoEF
Post-SPICE	V	Huayansi	Jiangshanian	42.4	DB-42.4	1.12	-10.26	23.4	803.3	0.13	0.019	0.90	4.42	1.05	0.06	0.02	17.5	14.1	6.2
Post-SPICE	V	Huayansi	Jiangshanian	41.4	DB-41.4	1.18	-10.21	19.3	2138.9	0.79	0.074	4.85				0.15	27.6		
Post-SPICE	V	Huayansi	Jiangshanian	39.7	DB-39.7	1.27	-10.23	30.8	1861.0	0.16	0.020	0.81	2.56	1.13	0.06	0.02	21.6	9.0	7.5
Post-SPICE	V	Huayansi	Jiangshanian	39	DB-39.0	1.14	-9.91			0.36	0.064	1.44				0.04	14.5		
Post-SPICE	V	Huayansi	Jiangshanian	38.3	DB-38.3	1.04	-10.06	29.4	821.8	0.15	0.021	0.56	1.54	0.31	0.04	0.01	18.8	8.0	3.0
Post-SPICE	V	Huayansi	Jiangshanian	37.6	DB-37.6	1.13	-9.49			0.09	0.022	0.38				0.01	10.6		
Post-SPICE	V	Huayansi	Jiangshanian	36.9	DB-36.9	1.06	-9.47	35.3	916.0	0.13	0.021	0.43	1.43	0.22	0.03	0.01	16.0	9.5	2.7
Post-SPICE	V	Huayansi	Jiangshanian	36.2	DB-36.2	1.13	-10.08			0.09	0.018	0.57				0.01	13.3		
Post-SPICE	V	Huayansi	Jiangshanian	35.5	DB-35.5	1.19	-9.91	29.3	86.7	0.14	0.018	0.62	0.88	0.33	0.05	0.03	19.6	4.1	2.9
Post-SPICE	V	Huayansi	Jiangshanian	34.8	DB-34.8	1.00	-9.18			0.11	0.019	0.24				0.01	14.7		
Post-SPICE	V	Huayansi	Jiangshanian	34.1	DB-34.1	0.95	-8.57	19.5	596.4	0.12	0.020	0.20	0.42	0.29	0.04	0.01	15.2	5.9	7.6
Post-SPICE	V	Huayansi	Jiangshanian	33.4	DB-33.4	1.09	-10.53			0.36	0.021	0.95				0.03	44.8		
Post-SPICE	V	Huayansi	Jiangshanian	32.7	DB-32.7	1.16	-10.40	20.8	402.9	0.27	0.022	0.84	0.88	0.73	0.12	0.21	31.4	3.0	4.7
Post-SPICE	V	Huayansi	Jiangshanian	32	DB-32	1.83	-7.09			0.15	0.021	0.79				0.02	19.0		

Post-SPICE	V	Huayansi	Jiangshanian	31.5	DB-31.5	0.69	-9.51	15.0	2924.0	0.30	0.026	2.36	4.72	2.11	0.20	0.08	29.7	5.7	4.8
Post-SPICE	V	Huayansi	Jiangshanian	31	DB-31	1.19	-10.64			0.13	0.021	1.14				0.03	16.9		
Post-SPICE	V	Huayansi	Jiangshanian	30.4	DB-30.4	0.99	-10.47	14.9	1979.6	0.10	0.066	0.47	1.72	0.45	0.13	0.01	3.8	10.5	5.1
Post-SPICE	V	Huayansi	Jiangshanian	29.85	DB-29.85	1.15	-10.22	15.6	697.9	0.03	0.034	0.69				0.01	2.1		
Post-SPICE	V	Huayansi	Jiangshanian	29.6	DB-29.6	0.86	-10.06			0.21	0.027	1.36	8.15	0.82	0.13	0.04	20.1	17.2	3.2
Falling SPICE	IV	Huayansi	Jiangshanian	28.8	DB-28.8	0.79	-10.24	24.9	404.3	0.02	0.022	0.64				0.01	2.4		
Falling SPICE	IV	Huayansi	Jiangshanian	28.2	DB-28.2	1.55	-10.33	25.8	489.4	0.03	0.024	0.65	1.44	0.07	0.29	0.01	2.8	6.3	1.0
Falling SPICE	IV	Huayansi	Jiangshanian	27.4	DB-27.4	1.62	-10.09	27.9	446.8	0.12	0.066	0.84				0.02	4.6		
Falling SPICE	IV	Huayansi	Jiangshanian	26.6	DB-26,6	1.98	-9.60	24.0	872.3	0.05	0.022	0.71	0.75	0.14	0.10	0.02	5.5	3.0	1.1
Falling SPICE	IV	Huayansi	Jiangshanian	25.9	DB-25,9	1.94	-8.95	22.3	1361.7	0.09	0.050	0.53				0.03	4.7		
Falling SPICE	IV	Huayansi	Jiangshanian	25.3	DB-25.3	1.99	-8.72	27.0	659.6	0.08	0.048	0.83	0.84	0.08	0.02	0.03	4.4	2.9	1.0
Falling SPICE	IV	Huayansi	Jiangshanian	24.4	*DB-24.4*	2.21	-9.68	28.6	85.1	0.02	0.019	0.48				0.02	3.1		
Falling SPICE	IV	Huayansi	Jiangshanian	23.8	DB-23.8	2.22	-8.93	23.1	85.1	0.09	0.064	0.47	0.65	0.10	0.03	0.02	3.5	3.9	1.1
Falling SPICE	IV	Huayansi	Jiangshanian	23	DB-23.0	2.31	-9.17	27.4	276.6	0.04	0.042	0.30				0.01	2.7		
Falling SPICE	IV	Huayansi	Jiangshanian	22.4	DB-22.4	2.28	-9.37	19.6	85.1	0.03	0.031	0.40	0.28	0.07	0.02	0.01	2.4	2.0	1.0
Falling SPICE	IV	Huayansi	Jiangshanian	21.8	DB-21.8	2.37	-10.04	21.0	85.1	0.08	0.043	0.51				0.01	5.1		

Falling SPICE	IV	Huayansi	Jiangshanian	21.2	DB-21.2	2.42	-10.00	25.9	510.6	0.12	0.019	0.84	3.18	0.71	0.03	0.02	16.3	10.9	4.5
Falling SPICE	IV	Huayansi	Jiangshanian	20.6	DB-20.6	2.49	-8.61	23.0	85.1	0.05	0.047	0.31				0.01	2.9		
Falling SPICE	IV	Huayansi	Jiangshanian	20	DB-20.0	2.71	-9.46	20.5	702.1	0.13	0.018	0.74	2.73	0.84	0.02	0.02	18.1	10.5	6.1
Falling SPICE	IV	Huayansi	Paibian	19.4	DB-19.4	2.66	-10.08	19.7	531.9	0.11	0.028	0.44				0.01	10.0		
Falling SPICE	IV	Huayansi	Paibian	18.8	B-18.8	2.86	-9.61		425.5	0.15	0.022	0.47	0.58	0.40	0.02	0.03	18.3	3.6	4.6
Falling SPICE	IV	Huayansi	Paibian	18.2	DB-18.2	2.88	-9.56	21.2	85.1	0.12	0.047	0.45				0.02	6.9		
Falling SPICE	IV	Huayansi	Paibian	17.6	DB-17.6	2.93	-9.75	25.6	468.1	0.14	0.019	0.84	2.76	1.33	0.03	0.02	19.5	9.4	8.4
Falling SPICE	IV	Huayansi	Paibian	17	DB-17.0	2.84	-10.43	23.2	404.3	0.11	0.019	0.61				0.02	15.2		
Falling SPICE	IV	Huayansi	Paibian	16.3	DB-16.3	3.61	-6.88	24.4	468.1	0.56	0.026	1.80	2.23	1.56	0.18	0.35	56.6	3.6	4.6
Falling SPICE	IV	Huayansi	Paibian	15.7	DB-15.7	2.99	-9.65	22.4	94.3	0.13	0.019	0.77				0.03	18.0		
Falling SPICE	IV	Huayansi	Paibian	15.3	DB-15.3	3.13	-9.48	25.5	720.0	0.24	0.029	1.03	2.09	0.60	0.05	0.07	21.8	5.8	3.1
Falling SPICE	IV	Huayansi	Paibian	14.5	DB-14.5	3.12	-9.31	26.6	81.7	0.10	0.018	0.61				0.03	14.8		
Falling SPICE	IV	Huayansi	Paibian	14	DB-14.0	3.16	-7.78	32.2	80.0	0.09	0.017	0.40	1.10	0.27	0.02	0.01	13.5	7.9	3.6
Falling SPICE	IV	Huayansi	Paibian	13.2	DB-13.2	2.99	-8.60	23.1	79.8	0.06	0.019	0.30				0.01	8.9		
Falling SPICE	IV	Huayansi	Paibian	12.6	DB-12.6	3.26	-9.36	27.7	100.0	0.13	0.105	0.50	1.14	2.28	0.02	0.02	3.2	6.5	24.4
Falling SPICE	IV	Huayansi	Paibian	12	DB-12.0	3.38	-9.28	25.2	298.7	0.14	0.019	0.64				0.03	19.4		

Falling SPICE	IV	Huayansi	Paibian	11.3	DB-11.3	3.26	-9.69	27.3	440.0	0.17	0.020	0.87	1.80	0.89	0.03	0.03	21.6	6.0	5.5
Falling SPICE	IV	Huayansi	Paibian	10.5	DB-10.5	3.11	-9.71	26.9	480.6	0.18	0.020	0.64				0.03	23.3		
Falling SPICE	IV	Huayansi	Paibian	9.9	DB-9.9	3.30	-9.79	36.7	180.0	0.21	0.147	0.71	0.98	0.37	0.03	0.02	3.6	3.9	2.8
Falling SPICE	IV	Huayansi	Paibian	9.1	DB-9.1	3.51	-10.17	30.6	140.1	0.17	0.020	0.60				0.04	21.4		
Falling SPICE	IV	Huayansi	Paibian	8.3	DB-8.3	3.59	-10.06	29.3	1140.0	0.30	0.024	1.73	2.37	2.08	0.05	0.05	32.7	3.9	6.5
Falling SPICE	IV	Huayansi	Paibian	7.5	DB-7.5	3.76	-10.23	29.4	611.4	0.21	0.021	1.11				0.04	26.7		
Falling SPICE	IV	Huayansi	Paibian	6.8	DB-6.8	3.70	-10.23	23.0	660.0	0.22	0.023	1.41	3.15	0.87	0.05	0.05	24.6	6.4	3.3
Falling SPICE	IV	Huayansi	Paibian	6	DB-6.0	3.83	-10.74	26.5	345.1	0.19	0.020	0.70				0.05	25.6		
Falling SPICE	IV	Huayansi	Paibian	5.5	DB-4.5	3.71	-9.95	21.2	78.6	0.11	0.019	0.61	0.76	0.37	0.02	0.05	14.3	3.6	3.3
Falling SPICE	IV	Huayansi	Paibian	5	DB-4.0	3.71	-12.22			0.14	0.019	0.67				0.08	19.3		
Falling SPICE	IV	Huayansi	Paibian	4	DB-3.4	4.16	-9.94	24.6	120.1	0.12	0.019	0.47	0.66	0.39	0.02	0.05	16.4	4.0	4.4
Falling SPICE	IV	Huayansi	Paibian	3	DB-2.7	3.75	-10.27			0.14	0.019	0.43				0.07	18.2		
Falling SPICE	IV	Huayansi	Paibian	2.2	DB-2.0	3.84	-9.92	23.8	1539.1	0.16	0.021	0.95	1.69	0.95	0.03	0.05	19.5	5.1	5.3
Falling SPICE	IV	Huayansi	Paibian	1.6	DB-1.45	3.75	-8.75			0.20	0.022	0.87				0.08	23.4		
Falling SPICE	IV	Huayansi	Paibian	1	DB-1.0	3.94	-8.70	25.0	1799.9	0.12	0.019	0.60	0.82	0.50	0.03	0.05	16.3	3.9	4.5