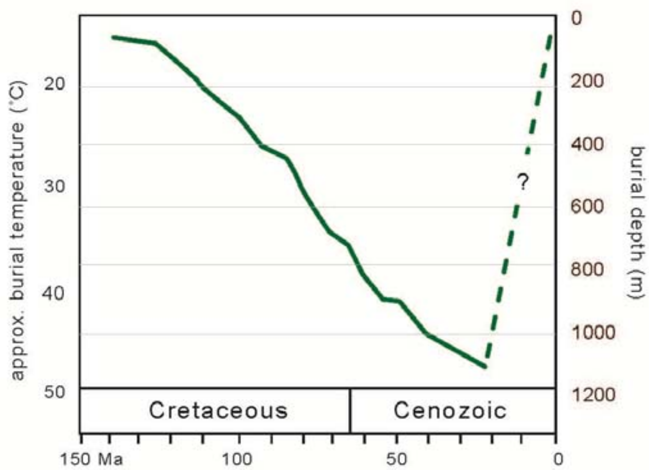

Figure DR1. Estimated burial history of the Yatria region (derived from measurements in Aldinsky et al. 1970; Vinogradov, 1968) showing the estimated maximum burial depth for the samples is less than 1200 m.

References for Figure DR1

Aldinsky, P.I., Pervago, V.A., and Zoloev, K.K., 1970, (Eds.) Geology of the USSR. T.XII. Perm, Sverdlovsk, Cheliabinsk and Kurgan districts. Pt.I. Geological destription. Book 1. Moscow, Nedra Press 724 p. (In Russian)

Vinogradov, A.P., 1968, (Ed.) Atlas litologo-paleogeograficheskykh kart SSSR. T.3. Triasovyi, yurskij i melovoi periody. [Atlas of lithological - palaeogeographical maps of the USSR. T.3. Triassic, Jurassic and Cretaceous times]. Vsesoyuznyi aerogeologichesky trest Mingeo SSSR, Moscow, 71 maps. (In Russian)

Table DR1. Stable isotope, Δ47composition of belemnites and reconstructed oxygen isotopic composition of the seawater, and trace element geochemistry.

Stage	Sample	Mn (ppm)	Fe (ppm)	*N**	$\delta^{13}C$ (‰, PDB)[&]	$\delta^{18}O$ (‰, PDB)[&&]	Δ_{47} (‰)† (Ghosh)	Δ_{47} (‰)†† (TES)	SD Δ_{47} (‰)§	Error Δ_{47} (‰)#	T (°C)** (Ghosh)	T (°C)*** (JHU-M)	SE, T, (°C)†††	$\delta^{18}O_{water}$ (‰) (SMOW)§§ (Ghosh)	$\delta^{18}O_{water}$ (‰) (SMOW)§§§ (JHU-M)	SE $\delta^{18}O_{water}$ (‰)##	T (°C)*** (JHU-M)	$\delta^{18}O_{water}$ (‰) (SMOW)§§§ (JHU-M)
	well preserved samples																	
Upper Valanginian	1.109.12.jhu.1	3	9	3	1.7	0.83	0.657	0.724	0.009	0.008	22.6	14.1	2.9	2.7	0.9	0.6		
Upper Valanginian	1.109.15.jhu.1	5	11	2	0.3	0.83	0.661	0.728	-	0.012	21.8	12.7	4.5	2.5	0.6	1.0		
Upper Valanginian	1.109.2.jhu.1	7	10	2	2.1	0.60	0.663	0.731	-	0.012	21.3	11.8	4.4	2.2	0.1	1.0	*Upper Valangian Mean*	
Upper Valanginian	1.109.22.jhu.1	4	11	2	1.5	0.46	0.656	0.723	-	0.012	22.9	14.6	4.6	2.4	0.6	1.0	12.7	0.4
Upper Valanginian	1.109.9.jhu.1	8	7	3	1.2	0.64	0.667	0.735	0.014	0.008	20.3	10.2	2.9	2.0	-0.2	0.7		
Lower Valanginian	YR1.25.jhu.1	5	12	3	0.6	-1.61	0.660	0.727	0.005	0.008	21.9	12.9	2.9	0.1	-1.8	0.6	*Lower Valangian Mean*	
Lower Valanginian	YR1.7.jhu.1	5	10	2	-0.8	-0.75	0.659	0.726	-	0.012	22.1	13.3	4.5	1.0	-0.9	1.0	13.0	-1.0
Lower Valanginian	YR1.8.jhu.1	5	11	3	0.7	-0.11	0.660	0.728	0.013	0.008	21.8	12.8	2.9	1.6	-0.4	0.6		
Berriasian (Volgian)	1.99.11.jhu.1	9	12	2	-0.8	-1.02	0.644	0.711	-	0.012	25.4	19.1	4.8	1.4	0.1	1.0		
Berriasian (Volgian)	1.99.12.jhu.1	23	15	2	0.9	-1.34	0.652	0.719	-	0.012	23.7	16.0	4.6	0.7	-0.9	1.0	*Berriasian Mean*	
Berriasian (Volgian)	1.99.15.jhu.1	19	13	3	-0.3	-1.47	0.651	0.719	0.017	0.010	23.8	16.2	3.8	0.6	-1.0	0.8	17.8	-0.7
Berriasian (Volgian)	1.99.3.jhu.1	9	18	3	0.3	-1.87	0.643	0.710	0.017	0.010	25.6	19.4	3.9	0.6	-0.7	0.8		
Berriasian (Volgian)	1.99.9.jhu.1	5	11	2	0.0	-1.99	0.645	0.712	-	0.012	25.1	18.5	4.8	0.4	-1.0	1.0		
	altered sample (based on trace elements)																	
?	1.100.8.jhu.1	20	185	2	-3.3	-2.7	0.668	0.736	-	0.012	20.1	9.9	4.4	-1.4	-3.6	1.0		
	altered samples (based on petrography)																	
Upper Valanginian	1.109.13.jhu.1	-	-	3	1.3	0.3	0.654	0.721	0.023	0.013	23.2	15.2	5.0	2.3	0.6	1.1		
Upper Valanginian	1.109.16.jhu.1	-	-	3	2.2	0.1	0.670	0.738	0.016	0.009	19.8	9.3	3.4	1.3	-1.0	0.8		
Lower Valanginian	YR1.17.jhu.1	-	-	3	1.0	-0.2	0.657	0.725	0.028	0.016	22.5	13.9	6.0	1.6	-0.2	1.3		

*Number of unique extractions and analyses of CO_2 from carbonate. Results from each extraction + analysis are reported in Supplementary Information.

[&]Reproducibility is 0.06‰ (1σ) or better, based on repeated measurements of in-house carbonate standards.

[&&]Reproducibility is 0.07‰ (1σ) or better, based on repeated measurements of in-house carbonate standards.

† Values relative to the 'Ghosh' Δ_{47} scale (Ghosh et al., 2006, as described in Huntington et al., 2009) and are normalized to a canonical heated gas intercept of -0.8453‰ relative to Oztech reference CO_2. An acid correction factor of +0.081‰ was used to normalize these data to 25 C phosphoric acid reactions (Passey et al., 2010).

†† Values relative to the 'theoretical equilibrium scale' (TES) (Dennis et al. 2011). An acid correction factor of +0.092‰ was used to normalize these data to 25 C phosphoric acid reactions (Henkes et al. 2013).

§ These are standard deviations of the populations of *N* Δ_{47} or $\delta^{18}O_{water}$ values for each sample (individual analyses are reported in Supplementary Information.

\# For N = 3, error is estimated as the standard devation of *N* Δ_{47} values divided by the squre root of *N*. When the computed SD of analyses is less than the long-term laboratory external precision (=0.013‰ as determined by repeated analyses of homogenous carbonate reference materials), the computed SD is replaced with a value of 0.013‰ before computing the standard error. For N = 2, error is estimated as the largest observed standard deviation in the 'well preserved' dataset (0.017), divided by the square root of N.

**Temperature is calculated from measured Δ_{47} values using the 'Ghosh' D47 scale (Ghosh et al. 2006), as converted to the TES scale (Dennis et al. 2011): $\Delta_{47} = (0.05920 \times 10^6) / T^2 - 0.02$.

***Temperature is calculated from measured Δ_{47} values using a mollusk-specific calibration equation (JHU-M) generated at Johns Hopkins University: $\Delta_{47} = (0.0327 \times 10^6) / T^2 + 0.3286$ (Henkes et al. 2013).

†††Temperature error is calculated using the analytical error propagated with the estimated error in the acid correction factor (=0.0024‰) (Passey et al., 2010), propagated through the JHU temperature equation (Henkes et al. 2013).

§§ Water composition is calculated based on $\delta^{18}O$ of carbonate and temperatures inferred from clumped isotopes ('Ghosh' D47 scale) using the calcite paleotemperature equation (Kim and O'Neil, 1997): $1000\ln\alpha = (18.03 \times 10^3)/T - 32.42$.

§§§ Water composition is calculated based on $\delta^{18}O$ of carbonate and temperatures inferred from clumped isotopes (Henkes et al. 2013) using the calcite paleotemperature equation of Kim and O'Neil (1997).

\## Error in $\delta^{18}O$ of water is calculated by propagating temperature error through the paleotemperature equation of Kim and O'Neil (1997).

The belemnites were derived from dark gray–green glauconitic silts and sands with calcareous and phosphatic concretions. Based upon the ammonite fauna (Golbert et al. 1975) the lower part of the unit has been assigned to the early Ryazanian (Berriasian), Kochi ammonite zone. Overlying, the Analogus and Payeri ammonite zones are recognized, followed by the Valanginian Insolutus, Michalskii and Ramulosus ammonite zones (Golbert et al. 1975). A Ryazanian –Valanginian age is confirmed by dinoflagellate biostratigraphy (e.g. Lebedeva & Nikitenko 1999).

Table DR2. An Excel spreadsheet containing all raw isotope data relevant to this study (including standards), data normalization calculations, and summarized results.

Sample Information

Counter	Analyst	Date	Type	Sample Number	Sample ID	spec #'s	Acid	Ref Gas	method
52	Ben	16_Nov_09	Sample	BP-CI-613	1.100.8.jhu.1	Acq-0707	16_Nov_0	16_Nov_0	Rx @90C, 12
91	Ben	24_Nov_09	Sample	BP-CI-653	1.100.8.jhu.1	Acq-1019	21_Nov_0	23_Nov_0	Rx @90C, 12
28	Ben	9_Nov_09	Sample	BP-CI-595	1.109.12.jhu.1	Acq-0515	5-Nov-09 p	9_Nov_09	Rx @90C, 12
57	Ben	17_Nov_09	Sample	BP-CI-618	1.109.12.jhu.1	Acq-0747	16_Nov_0	16_Nov_0	Rx @90C, 12
92	Ben	24_Nov_09	Sample	BP-CI-654	1.109.12.jhu.1	Acq-1027	21_Nov_0	23_Nov_0	Rx @90C, 12
29	Ben	9_Nov_09	Sample	BP-CI-596	1.109.13.jhu.1	Acq-0523	5-Nov-09 p	9_Nov_09	Rx @90C, 12
54	Ben	17_Nov_09	Sample	BP-CI-616	1.109.13.jhu.1	Acq-0723	16_Nov_0	16_Nov_0	Rx @90C, 12
88	Ben	23_Nov_09	Sample	BP-CI-651	1.109.13.jhu.1	Acq-0995	21_Nov_0	23_Nov_0	Rx @90C, 12
36	Ben	10_Nov_09	Sample	BP-CI-601	1.109.15.jhu.1	Acq-0579	9_Nov_09	10_Nov_0	Rx @90C, 12
95	Ben	24_Nov_09	Sample	BP-CI-657	1.109.15.jhu.1	Acq-1051	21_Nov_0	23_Nov_0	Rx @90C, 12
40	Ben	13_Nov_09	Sample	BP-CI-603	1.109.16.jhu.1	Acq-0611	9_Nov_09	13_Nov_0	Rx @90C, 12
61	Ben	18_Nov_09	Sample	BP-CI-621	1.109.16.jhu.1	Acq-0779	16_Nov_0	16_Nov_0	Rx @90C, 12
73	Ben	20_Nov_09	Sample	BP-CI-638	1.109.16.jhu.1	Acq-0875	16_Nov_0	20_Nov_0	Rx @90C, 12
50	Ben	16_Nov_09	Sample	BP-CI-611	1.109.2.jhu.1	Acq-0691	16_Nov_0	16_Nov_0	Rx @90C, 12
86	Ben	23_Nov_09	Sample	BP-CI-649	1.109.2.jhu.1	Acq-0979	21_Nov_0	23_Nov_0	Rx @90C, 12
44	Ben	14_Nov_09	Sample	BP-CI-607	1.109.22.jhu.1	Acq-0643	9_Nov_09	13_Nov_0	Rx @90C, 12
72	Ben	20_Nov_09	Sample	BP-CI-637	1.109.22.jhu.1	Acq-0867	16_Nov_0	20_Nov_0	Rx @90C, 12
34	Ben	10_Nov_09	Sample	BP-CI-599	1.109.9.jhu.1	Acq-0563	9_Nov_09	10_Nov_0	Rx @90C, 12
67	Ben	19_Nov_09	Sample	BP-CI-626	1.109.9.jhu.1	Acq-0827	16_Nov_0	19_Nov_0	Rx @90C, 12
82	Ben	22_Nov_09	Sample	BP-CI-646	1.109.9.jhu.1	Acq-0947	21_Nov_0	21_Nov_0	Rx @90C, 12
37	Ben	11_Nov_09	Sample	BP-CI-602	1.99.11.jhu.1	Acq-0587	9_Nov_09	10_Nov_0	Rx @90C, 12
78	Ben	21_Nov_09	Sample	BP-CI-642	1.99.11.jhu.1	Acq-0915	21_Nov_0	21_Nov_0	Rx @90C, 12
33	Ben	9_Nov_09	Sample	BP-CI-598	1.99.12.jhu.1	Acq-0555	9_Nov_09	9_Nov_09	Rx @90C, 12
84	Ben	22_Nov_09	Sample	BP-CI-647	1.99.12.jhu.1	Acq-0963	21_Nov_0	21_Nov_0	Rx @90C, 12
26	Ben	8_Nov_09	Sample	BP-CI-594	1.99.15.jhu.1	Acq-0499	5-Nov-09 p	7_Nov_09	Rx @90C, 12
59	Ben	18_Nov_09	Sample	BP-CI-620	1.99.15.jhu.1	Acq-0763	16_Nov_0	16_Nov_0	Rx @90C, 12
76	Ben	21_Nov_09	Sample	BP-CI-641	1.99.15.jhu.1	Acq-0899	16_Nov_0	20_Nov_0	Rx @90C, 12
48	Ben	16_Nov_09	Sample	BP-CI-610	1.99.3.jhu.1	Acq-0675	9_Nov_09	16_Nov_0	Rx @90C, 12
62	Ben	18_Nov_09	Sample	BP-CI-622	1.99.3.jhu.1	Acq-0787	16_Nov_0	16_Nov_0	Rx @90C, 12
85	Ben	23_Nov_09	Sample	BP-CI-648	1.99.3.jhu.1	Acq-0971	21_Nov_0	23_Nov_0	Rx @90C, 12
43	Ben	13_Nov_09	Sample	BP-CI-606	1.99.9.jhu.1	Acq-0635	9_Nov_09	13_Nov_0	Rx @90C, 12
80	Ben	22_Nov_09	Sample	BP-CI-644	1.99.9.jhu.1	Acq-0931	21_Nov_0	21_Nov_0	Rx @90C, 12
32	Ben	9_Nov_09	Sample	BP-CI-597	YR1.17.jhu.1	Acq-0547	9_Nov_09	9_Nov_09	Rx @90C, 12
63	Ben	19_Nov_09	Sample	BP-CI-623	YR1.17.jhu.1	Acq-0795	16_Nov_0	19_Nov_0	Rx @90C, 12
70	Ben	20_Nov_09	Sample	BP-CI-636	YR1.17.jhu.1	Acq-0851	16_Nov_0	19_Nov_0	Rx @90C, 12
24	Ben	8_Nov_09	Sample	BP-CI-593	YR1.25.jhu.1	Acq-0483	5-Nov-09 p	7_Nov_09	Rx @90C, 12
55	Ben	17_Nov_09	Sample	BP-CI-617	YR1.25.jhu.1	Acq-0731	16_Nov_0	16_Nov_0	Rx @90C, 12
79	Ben	22_Nov_09	Sample	BP-CI-643	YR1.25.jhu.1	Acq-0923	21_Nov_0	21_Nov_0	Rx @90C, 12
47	Ben	14_Nov_09	Sample	BP-CI-609	YR1.7.jhu.1	Acq-0667	9_Nov_09	14_Nov_0	Rx @90C, 12
74	Ben	21_Nov_09	Sample	BP-CI-639	YR1.7.jhu.1	Acq-0883	16_Nov_0	20_Nov_0	Rx @90C, 12
42	Ben	13_Nov_09	Sample	BP-CI-605	YR1.8.jhu.1	Acq-0627	9_Nov_09	13_Nov_0	Rx @90C, 12
66	Ben	19_Nov_09	Sample	BP-CI-625	YR1.8.jhu.1	Acq-0819	16_Nov_0	19_Nov_0	Rx @90C, 12
96	Ben	24_Nov_09	Sample	BP-CI-658	YR1.8.jhu.1	Acq-1059	21_Nov_0	23_Nov_0	Rx @90C, 12
30	Ben	9_Nov_09	Standard	BP-CI-592	102-GC-AZ01	Acq-0531	5-Nov-09 p	9_Nov_09	Rx @90C, 12
45	Ben	14_Nov_09	Standard	BP-CI-608	102-GC-AZ01	Acq-0651	9_Nov_09	14_Nov_0	Rx @90C, 12
58	Ben	18_Nov_09	Standard	BP-CI-619	102-GC-AZ01	Acq-0755	16_Nov_0	16_Nov_0	Rx @90C, 12
81	Ben	22_Nov_09	Standard	BP-CI-645	102-GC-AZ01	Acq-0939	21_Nov_0	21_Nov_0	Rx @90C, 12
93	Ben	24_Nov_09	Standard	BP-CI-655	102-GC-AZ01	Acq-1035	21_Nov_0	23_Nov_0	Rx @90C, 12
21	Ben	7_Nov_09	Standard	BP-CI-588	2-8-E bottle 4	Acq-0459	5-Nov-09 p	6-Nov-09 a	Rx @90C, 10
35	Ben	10_Nov_09	Standard	BP-CI-600	2-8-E bottle 4	Acq-0571	9_Nov_09	10_Nov_0	Rx @90C, 12
69	Ben	20_Nov_09	Standard	BP-CI-628	2-8-E bottle 4	Acq-0843	16_Nov_0	19_Nov_0	Rx @90C, 12
46	Ben	14_Nov_09	Standard	BP-CI-615	2-8-E bottle 4, finer materia	Acq-0659	9_Nov_09	14_Nov_0	Rx @90C, 12
51	Ben	16_Nov_09	Sample	BP-CI-612	Hagit Carrara	Acq-0699	16_Nov_0	16_Nov_0	Rx @90C, 12
15	Ben	6_Nov_09	Standard	BP-CI-583	NBS-19	Acq-0411	5-Nov-09 p	6-Nov-09 a	Rx @90C, 10
75	Ben	21_Nov_09	Standard	BP-CI-640	NBS-19	Acq-0891	16_Nov_0	20_Nov_0	Rx @90C, 12
5	Ben	2_Nov_08	Standard	BP-CI-572	UU Carrara	Acq-0331			Rx @90C, 15
20	Ben	7_Nov_09	Standard	BP-CI-587	UU Carrara	Acq-0451	5-Nov-09 p	6-Nov-09 a	Rx @90C, 10
27	Ben	8_Nov_09	Standard	BP-CI-591	UU Carrara	Acq-0507	5-Nov-09 p	7_Nov_09	Rx @90C, 12
39	Ben	13_Nov_09	Standard	BP-CI-604	UU Carrara	Acq-0603	9_Nov_09	13_Nov_0	Rx @90C, 12
64	Ben	19_Nov_09	Standard	BP-CI-624	UU Carrara	Acq-0803	16_Nov_0	19_Nov_0	Rx @90C, 12
87	Ben	23_Nov_09	Standard	BP-CI-650	UU Carrara	Acq-0987	21_Nov_0	23_Nov_0	Rx @90C, 12
12	Ben	6_Nov_09	Heated Ga	BP-CI-574	Heated Evap CO2	Acq-0387	5-Nov-09 p	6-Nov-09 a	Rx @90C, 10
18	Ben	7_Nov_09	Heated Ga	BP-CI-577	Heated Reg CO2	Acq-0435	5-Nov-09 p	6-Nov-09 a	Rx @90C, 10
25	Ben	8_Nov_09	Heated Ga	BP-CI-576	Heated Evap CO2	Acq-0491	5-Nov-09 p	7_Nov_09	Rx @90C, 12
31	Ben	9_Nov_09	Heated Ga	BP-CI-579	Heated Reg CO2	Acq-0539	5-Nov-09 p	9_Nov_09	Rx @90C, 12
38	Ben	11_Nov_09	Heated Ga	BP-CI-573	Heated Evap CO2	Acq-0595	9_Nov_09	10_Nov_0	Rx @90C, 12
41	Ben	13_Nov_09	Heated Ga	BP-CI-578	Heated Reg CO2	Acq-0619	9_Nov_09	13_Nov_0	Rx @90C, 12
49	Ben	16_Nov_09	Heated Ga	BP-CI-575	Heated Evap CO2	Acq-0683	9_Nov_09	16_Nov_0	Rx @90C, 12
56	Ben	17_Nov_09	Heated Ga	BP-CI-479	Heated BOC	Acq-0739	16_Nov_0	16_Nov_0	Rx @90C, 12
60	Ben	18_Nov_09	Heated Ga	BP-CI-629	Heated Evap CO2	Acq-0771	16_Nov_0	16_Nov_0	Rx @90C, 12
65	Ben	19_Nov_09	Heated Ga	BP-CI-633	Heated Reg CO2	Acq-0811	16_Nov_0	19_Nov_0	Rx @90C, 12
71	Ben	20_Nov_09	Heated Ga	BP-CI-632	Heated Evap CO2	Acq-0859	16_Nov_0	20_Nov_0	Rx @90C, 12
77	Ben	21_Nov_09	Heated Ga	BP-CI-634	Heated Reg CO2	Acq-0907	16_Nov_0	20_Nov_0	Rx @90C, 12
83	Ben	22_Nov_09	Heated Ga	BP-CI-630	Heated Evap CO2	Acq-0955	21_Nov_0	21_Nov_0	Rx @90C, 12
89	Ben	23_Nov_09	Heated Ga	BP-CI-635	Heated Reg CO2	Acq-1003	21_Nov_0	23_Nov_0	Rx @90C, 12
97	Ben	25_Nov_09	Heated Ga	BP-CI-631	Heated Evap CO2	Acq-1067	21_Nov_0	23_Nov_0	Rx @90C, 12

Raw Mass Spectrometric Data

Counter	voltage (mV)	$\delta^{13}C$ (PDB)	$\delta^{13}C$ stdev	$\delta^{18}O$ gas (SMOW)	$\delta^{18}O$ mineral (PDB)	$\delta^{18}O$ stdev	δ_{47} (v. Oz)	δ_{47} stdev	Δ_{47} (v. Oz)	Δ_{47} stdev	Δ_{47} sterror	δ_{48} (v. Oz)	Δ_{48} (v. Oz)	Δ_{48} stdev	δ_{49} (v. Oz)	Δ_{49} (v. Oz)	Δ_{49} stdev
52	11897	-3.140	0.003	36.514	-2.703	0.003	11.644	0.089	-0.250	0.026	0.009	22.990	0.623	0.129	13.384	-9.520	0.387
91	11925	-3.220	0.003	36.442	-2.772	0.004	11.479	0.087	-0.268	0.018	0.006	23.469	1.244	0.179	13.595	-9.097	0.308
28	11924	1.774	0.001	40.106	0.753	0.013	19.997	0.108	-0.291	0.036	0.013	30.343	0.913	0.493	17.342	-17.352	1.461
57	11893	1.780	0.003	40.142	0.788	0.009	20.037	0.074	-0.291	0.031	0.011	30.618	1.115	0.089	17.766	-17.017	0.410
92	11930	1.770	0.004	40.141	0.787	0.002	20.042	0.100	-0.276	0.027	0.010	30.861	1.336	0.172	17.660	-17.107	0.663
29	11968	1.379	0.003	39.583	0.249	0.011	19.113	0.091	-0.263	0.022	0.008	29.426	1.005	0.114	16.507	-16.782	0.281
54	11901	1.334	0.002	39.540	0.208	0.011	18.996	0.083	-0.293	0.025	0.009	29.084	0.783	0.149	16.453	-16.709	0.418
88	11894	1.360	0.002	39.550	0.218	0.006	19.020	0.080	-0.304	0.034	0.012	29.792	1.465	0.156	18.154	-15.109	0.348
36	11917	0.365	0.003	40.121	0.767	0.005	18.634	0.093	-0.285	0.052	0.018	30.448	0.981	0.102	16.898	-16.426	0.249
95	11911	0.395	0.004	40.143	0.789	0.007	18.695	0.077	-0.274	0.020	0.007	31.201	1.661	0.150	18.487	-14.959	0.293
40	11922	2.263	0.003	39.272	-0.049	0.009	19.663	0.086	-0.267	0.022	0.008	28.307	0.525	0.182	15.852	-17.695	0.251
61	11956	2.233	0.002	39.345	0.021	0.009	19.713	0.081	-0.261	0.022	0.008	29.105	1.153	0.146	16.278	-17.391	0.411
73	11897	2.275	0.003	39.388	0.062	0.005	19.771	0.084	-0.289	0.022	0.008	29.471	1.450	0.193	17.064	-16.754	0.377
50	11898	2.181	0.004	39.901	0.556	0.007	20.198	0.080	-0.283	0.048	0.017	29.638	0.619	0.113	16.738	-17.947	0.263
86	11965	2.177	0.003	39.898	0.553	0.002	20.197	0.083	-0.277	0.025	0.009	30.441	1.399	0.116	17.664	-17.044	0.452
44	11929	1.658	0.002	39.731	0.392	0.009	19.497	0.099	-0.301	0.029	0.010	29.412	0.744	0.129	16.537	-17.306	0.251
72	11952	1.628	0.004	39.764	0.424	0.005	19.532	0.077	-0.270	0.034	0.012	30.089	1.305	0.220	17.504	-16.406	0.271
34	11927	1.295	0.002	39.925	0.579	0.004	19.347	0.088	-0.287	0.034	0.012	29.761	0.697	0.150	15.829	-18.002	0.623
67	11888	1.284	0.001	39.949	0.601	0.010	19.372	0.085	-0.275	0.034	0.012	30.454	1.312	0.083	17.713	-16.215	0.482
82	11928	1.266	0.003	39.944	0.597	0.013	19.363	0.095	-0.261	0.041	0.014	30.561	1.414	0.096	17.909	-15.998	0.308
37	11928	-0.730	0.003	38.248	-1.035	0.007	15.701	0.093	-0.279	0.028	0.010	26.454	0.693	0.236	14.506	-14.116	0.404
78	11860	-0.767	0.003	38.174	-1.106	0.004	15.567	0.091	-0.301	0.038	0.013	26.743	1.141	0.147	15.256	-13.210	0.409
33	11930	0.971	0.004	37.879	-1.389	0.005	17.006	0.085	-0.271	0.033	0.012	26.150	1.102	0.147	14.786	-14.820	0.308
84	11873	0.933	0.003	37.876	-1.393	0.008	16.937	0.087	-0.298	0.038	0.013	26.425	1.407	0.198	15.608	-13.979	0.365
26	11887	-0.196	0.002	37.730	-1.533	0.004	15.709	0.094	-0.274	0.032	0.011	25.576	0.836	0.161	14.298	-13.861	0.613
59	11916	-0.189	0.002	37.745	-1.519	0.008	15.705	0.081	-0.301	0.033	0.012	25.695	0.948	0.105	14.383	-13.814	0.288
76	11915	-0.187	0.006	37.769	-1.496	0.008	15.758	0.075	-0.274	0.018	0.006	26.022	1.194	0.200	15.073	-13.191	0.224
48	11949	0.321	0.002	37.305	-1.942	0.011	15.773	0.068	-0.293	0.050	0.018	24.328	0.456	0.133	13.971	-13.881	0.472
62	11899	0.391	0.002	37.320	-1.927	0.006	15.875	0.072	-0.275	0.050	0.018	24.962	1.029	0.151	14.697	-13.273	0.374
85	11916	0.349	0.004	37.357	-1.892	0.003	15.839	0.086	-0.306	0.043	0.015	25.034	1.060	0.189	14.889	-13.114	0.529
43	11899	0.119	0.002	37.208	-2.036	0.006	15.481	0.091	-0.289	0.030	0.010	24.554	0.861	0.161	13.713	-13.747	0.291
80	11897	0.100	0.001	37.206	-2.037	0.011	15.464	0.076	-0.287	0.031	0.011	24.769	1.073	0.164	14.382	-13.075	0.278
32	11921	1.085	0.003	39.049	-0.264	0.005	18.278	0.073	-0.281	0.032	0.011	28.462	1.104	0.137	16.001	-15.973	0.381
63	11903	1.088	0.003	39.066	-0.247	0.008	18.266	0.100	-0.308	0.018	0.006	28.226	0.877	0.161	16.128	-15.885	0.433
70	11944	1.099	0.003	39.069	-0.245	0.003	18.333	0.078	-0.256	0.042	0.015	28.717	1.297	0.086	15.958	-16.065	0.291
24	11912	0.674	0.004	37.588	-1.670	0.006	16.413	0.090	-0.280	0.029	0.010	25.235	0.785	0.145	14.275	-14.470	0.390
55	11893	0.662	0.002	37.606	-1.653	0.005	16.421	0.071	-0.277	0.035	0.012	25.229	0.744	0.191	14.258	-14.509	0.501
79	11905	0.679	0.002	37.601	-1.658	0.015	16.440	0.074	-0.271	0.030	0.011	25.512	1.021	0.128	14.745	-14.043	0.568
47	11932	-0.744	0.003	38.438	-0.852	0.005	15.892	0.079	-0.263	0.054	0.019	27.032	0.875	0.202	15.461	-13.537	0.310
74	11889	-0.668	0.003	38.554	-0.740	0.010	16.054	0.077	-0.290	0.029	0.010	27.368	1.006	0.089	15.209	-14.076	0.453
42	11924	0.785	0.007	39.088	-0.227	0.024	18.009	0.099	-0.279	0.030	0.011	28.348	0.948	0.223	16.014	-15.739	0.453
66	11934	0.790	0.003	39.187	-0.131	0.005	18.137	0.068	-0.267	0.021	0.007	28.720	1.082	0.152	16.262	-15.691	0.263
96	11909	0.802	0.001	39.180	-0.138	0.014	18.117	0.078	-0.291	0.023	0.008	29.288	1.674	0.197	16.926	-15.047	0.449
30	11975	0.477	0.005	24.287	-14.468	0.015	2.960	0.072	-0.266	0.034	0.012	-1.553	0.122	0.364	-0.221	-2.966	0.365
45	11942	0.504	0.003	24.434	-14.326	0.009	3.129	0.072	-0.270	0.032	0.011	-1.149	0.242	0.162	-0.154	-3.213	0.349
58	11915	0.510	0.002	24.347	-14.410	0.006	3.066	0.083	-0.253	0.027	0.010	-1.302	0.242	0.141	0.582	-2.315	0.575
81	11911	0.362	0.004	24.242	-14.511	0.005	2.804	0.078	-0.268	0.017	0.006	-1.507	0.256	0.110	0.422	-2.123	0.452
93	11909	0.456	0.004	24.272	-14.482	0.003	2.930	0.087	-0.261	0.037	0.013	-1.591	0.108	0.136	1.005	-1.695	0.293
21	11939	-8.936	0.005	32.734	-6.340	0.007	2.205	0.092	-0.287	0.029	0.010	15.314	0.422	0.174	8.097	-1.657	0.486
35	11910	-9.598	0.002	32.828	-6.249	0.006	1.650	0.093	-0.290	0.016	0.006	15.650	0.571	0.160	9.100	-0.178	0.384
69	11913	-8.899	0.004	32.764	-6.311	0.005	2.294	0.093	-0.264	0.030	0.010	15.671	0.692	0.285	9.222	-0.638	0.299
46	11951	-9.111	0.004	32.781	-6.295	0.006	2.100	0.069	-0.268	0.023	0.008	15.605	0.598	0.107	8.965	-0.712	0.297
51	11913	2.342	0.003	37.420	-1.831	0.007	17.548	0.091	-0.603	0.030	0.011	24.679	0.894	0.146	14.368	-15.702	0.438
15	11939	2.028	0.003	36.979	-2.255	0.005	16.838	0.099	-0.564	0.028	0.010	23.632	0.687	0.127	13.133	-15.756	0.306
75	11904	2.033	0.005	37.020	-2.216	0.007	16.866	0.085	-0.583	0.043	0.015	24.281	1.259	0.147	14.012	-14.985	0.315
5	11961	2.151	0.004	37.372	-1.877	0.007	17.345	0.077	-0.572	0.022	0.008	24.260	-0.007	0.087			
20	11871	2.151	0.003	37.310	-1.938	0.002	17.282	0.083	-0.572	0.026	0.009	24.526	0.927	0.128	13.647	-16.005	0.569
27	11918	2.145	0.001	37.322	-1.926	0.006	17.300	0.081	-0.560	0.022	0.008	24.835	1.194	0.233	14.391	-15.301	0.456
39	11961	2.166	0.003	37.300	-1.947	0.016	17.292	0.071	-0.567	0.055	0.020	24.105	0.531	0.083	13.266	-16.371	0.637
64	11912	2.172	0.004	37.369	-1.881	0.019	17.356	0.074	-0.578	0.030	0.011	24.723	1.011	0.133	14.534	-15.277	0.473
87	11953	2.170	0.006	37.389	-1.861	0.005	17.392	0.104	-0.561	0.030	0.011	25.356	1.572	0.099	15.363	-14.510	0.465
12	11951	-5.764	0.008	43.095	3.628	0.025	15.043	0.094	-0.812	0.043	0.015	35.209	0.376	0.152	18.256	-14.683	0.368
18	11956	-5.747	0.007	28.166	-10.735	0.027	0.253	0.093	-0.811	0.035	0.012	5.929	0.545	0.081	3.151	-0.923	0.227
25	11922	-5.297	0.002	43.983	4.483	0.005	16.352	0.095	-0.839	0.029	0.010	37.881	1.285	0.110	20.417	-14.734	0.356
31	11957	-5.728	0.007	27.842	-11.047	0.003	-0.025	0.098	-0.787	0.043	0.015	5.348	0.575	0.170	2.995	-0.467	0.460
38	11940	-5.672	0.004	43.552	4.068	0.016	15.553	0.088	-0.843	0.034	0.012	37.140	1.398	0.262	19.892	-14.055	0.452
41	11965	-5.742	0.013	27.922	-10.970	0.004	0.014	0.070	-0.814	0.021	0.007	5.595	0.690	0.127	3.153	-0.452	0.423
49	11933	-6.157	0.005	42.689	3.238	0.021	14.196	0.073	-0.867	0.018	0.006	34.958	0.971	0.205	19.059	-12.748	0.381
56	11936	-10.201	0.003	30.502	-8.488	0.006	-1.755	0.091	-0.811	0.027	0.010	10.812	0.830	0.199	6.107	1.972	0.492
60	11979	-5.682	0.003	43.462	3.982	0.017	15.442	0.080	-0.854	0.021	0.007	37.108	1.553	0.186	20.375	-13.410	0.231
65	11922	-5.706	0.003	28.098	-10.800	0.023	0.202	0.073	-0.835	0.037	0.013	5.985	0.757	0.189	3.499	-0.487	0.362
71	11934	-5.816	0.009	43.054	3.590	0.008	14.907	0.097	-0.854	0.037	0.013	36.588	1.831	0.210	20.235	-12.640	0.252
77	11924	-5.744	0.004	27.712	-11.172	0.005	-0.230	0.077	-0.847	0.022	0.008	5.270	0.809	0.057	3.696	0.500	0.366
83	11919	-5.748	0.003	43.084	3.618	0.017	14.990	0.086	-0.867	0.035	0.012	36.747	1.940	0.116	20.332	-12.670	0.538
89	11934	-5.759	0.007	27.643	-11.239	0.004	-0.307	0.095	-0.843	0.033	0.012	5.018	0.687	0.106	4.255	1.207	0.415
97	11946	-5.605	0.014	43.582	4.098	0.008	15.624	0.094	-0.868	0.038	0.013	38.063	2.253	0.123	21.465	-12.658	0.340

Ghosh Scale Δ47 corrections / New "CDES" Scale Corrections / Temperature Interpretations

Counter	Δ_{47} @ d47 = 0	Δ_{47} v. heated	Δ_{47} stretch to -0.8453 ca	Δ_{47} acid temp correction (	Δ_{47} accepted, standard	Offset	Δ_{47} Ghosh Sca	Δ_{47} Dennis et al. 2	Temp&& Ghosh	Temp** Guo	Temp## Dennis&Schrag	Temp^^' JHU mollusk	Stdev	Stdev	Difference (N = 2)	Reject? Why?
52	-0.228	0.593	0.610	0.691			0.677	0.746	17.8	7.6	9.1	6.6				altered trace elements
91	-0.246	0.576	0.592	0.673			0.659	0.727	21.6	13.2	15.2	13.2	0.012922	0.013536	0.019143	altered trace elements
28	-0.253	0.568	0.585	0.666			0.652	0.719	23.2	15.7	17.9	16.1				
57	-0.253	0.568	0.585	0.666			0.652	0.719	23.2	15.7	17.9	16.1				
92	-0.238	0.583	0.600	0.681			0.667	0.736	19.9	10.7	12.5	10.3	0.008943	0.009368		
29	-0.228	0.594	0.611	0.692			0.678	0.747	17.7	7.3	8.8	6.3				altered petrotraphy
54	-0.257	0.564	0.580	0.661			0.647	0.715	24.1	17.0	19.4	17.7				altered petrotraphy
88	-0.269	0.553	0.569	0.650			0.636	0.703	26.6	20.9	23.6	22.3	0.021801	0.022836		altered petrotraphy
36	-0.250	0.572	0.588	0.669			0.655	0.723	22.5	14.6	16.7	14.9				
95	-0.239	0.583	0.599	0.680			0.666	0.735	20.1	11.0	12.8	10.6	0.008089	0.008473	0.011983	
40	-0.230	0.591	0.608	0.689			0.675	0.744	18.3	8.2	9.8	7.4				altered petrotraphy
61	-0.224	0.598	0.615	0.696			0.682	0.751	17.0	6.3	7.7	5.1				altered petrotraphy
73	-0.252	0.569	0.586	0.667			0.653	0.721	23.0	15.3	17.5	15.7	0.015242	0.015965		altered petrotraphy
50	-0.245	0.577	0.593	0.674			0.660	0.728	21.4	12.9	14.9	12.8				
86	-0.240	0.582	0.599	0.680			0.666	0.734	20.2	11.1	12.9	10.7	0.004045	0.004237	0.005993	
44	-0.265	0.557	0.573	0.654			0.640	0.707	25.8	19.7	22.3	20.9				
72	-0.234	0.588	0.605	0.686			0.672	0.740	19.0	9.3	11.0	8.6	0.022673	0.02375	0.033587	
34	-0.250	0.571	0.588	0.669			0.655	0.723	22.6	14.7	16.8	14.9				
67	-0.239	0.583	0.600	0.681			0.667	0.735	20.0	10.9	12.7	10.5				
82	-0.225	0.597	0.614	0.695			0.681	0.750	17.2	6.6	8.1	5.5	0.012967	0.013583		
37	-0.249	0.572	0.589	0.670			0.656	0.724	22.3	14.3	16.4	14.5				
78	-0.272	0.550	0.565	0.646			0.632	0.699	27.4	22.2	25.0	23.9	0.01649	0.017273	0.024428	
33	-0.240	0.582	0.599	0.680			0.666	0.734	20.2	11.1	12.9	10.8				
84	-0.266	0.555	0.571	0.652			0.638	0.705	26.1	20.2	22.8	21.4	0.019501	0.020427	0.028889	
26	-0.244	0.577	0.594	0.675			0.661	0.729	21.2	12.7	14.6	12.6				
59	-0.272	0.550	0.566	0.647			0.633	0.700	27.3	22.1	24.8	23.7				
76	-0.244	0.577	0.594	0.675			0.661	0.729	21.3	12.7	14.6	12.6	0.01625	0.017022		
48	-0.263	0.559	0.575	0.656			0.642	0.709	25.4	19.0	21.5	20.0				
62	-0.245	0.577	0.593	0.674			0.660	0.728	21.4	12.9	14.9	12.9				
85	-0.276	0.546	0.561	0.642			0.628	0.695	28.4	23.7	26.6	25.6	0.01597	0.016729		
43	-0.260	0.562	0.578	0.659			0.645	0.712	24.7	18.0	20.4	18.9				
80	-0.259	0.563	0.579	0.660			0.646	0.714	24.4	17.4	19.8	18.2	0.001222	0.00128	0.00181	
32	-0.247	0.575	0.591	0.672			0.658	0.726	21.9	13.6	15.6	13.7				altered petrotraphy
63	-0.274	0.548	0.563	0.644			0.630	0.697	27.9	22.9	25.8	24.7				altered petrotraphy
70	-0.222	0.600	0.617	0.698			0.684	0.753	16.6	5.7	7.1	4.4	0.026659	0.027925		altered petrotraphy
24	-0.249	0.573	0.589	0.670			0.656	0.724	22.3	14.2	16.3	14.4				
55	-0.246	0.576	0.592	0.673			0.659	0.727	21.6	13.2	15.2	13.2				
79	-0.241	0.581	0.598	0.679			0.665	0.733	20.4	11.5	13.3	11.2	0.00438	0.004588		
47	-0.233	0.589	0.606	0.687			0.673	0.741	18.8	9.0	10.6	8.3				
74	-0.260	0.562	0.578	0.659			0.645	0.713	24.6	17.8	20.2	18.6	0.019365	0.020284	0.028686	
42	-0.245	0.577	0.593	0.674			0.660	0.728	21.4	12.9	14.9	12.9				
66	-0.233	0.589	0.606	0.687			0.673	0.742	18.8	8.9	10.6	8.2				
96	-0.257	0.565	0.581	0.662			0.648	0.716	24.0	16.8	19.1	17.4	0.012343	0.012929		
30	-0.260	0.562	0.578	0.659	0.650	0.009	0.645	0.712								
45	-0.265	0.557	0.573	0.654	0.650	0.004	0.640	0.707	22.4	14.5	16.6	14.7	Mean Temps			
58	-0.247	0.575	0.591	0.672	0.650	0.022	0.658	0.726								
81	-0.263	0.559	0.575	0.656	0.650	0.006	0.642	0.710								
93	-0.256	0.566	0.582	0.663	0.650	0.013	0.649	0.717								
21	-0.283	0.539	0.554	0.635	0.642	-0.007	0.621	0.688								
35	-0.286	0.535	0.551	0.632	0.642	-0.010	0.618	0.684								
69	-0.260	0.562	0.578	0.659	0.642	0.017	0.645	0.713								
46	-0.264	0.558	0.574	0.655	0.642	0.013	0.641	0.708								
51	-0.570	0.252	0.259	0.340	0.352	-0.012	0.326	0.378								
15	-0.533	0.289	0.297	0.378	0.352	0.026	0.364	0.418								
75	-0.551	0.271	0.278	0.359	0.352	0.007	0.345	0.399								
5	-0.540	0.282	0.290	0.371	0.352	0.019	0.357	0.411								
20	-0.540	0.282	0.290	0.371	0.352	0.019	0.357	0.411								
27	-0.528	0.294	0.302	0.383	0.352	0.031	0.369	0.424								
39	-0.535	0.287	0.295	0.376	0.352	0.024	0.362	0.416								
64	-0.545	0.276	0.284	0.365	0.352	0.013	0.351	0.405								
87	-0.529	0.293	0.301	0.382	0.352	0.030	0.368	0.423								
12	-0.784	0.038														
18	-0.811	0.011														
25	-0.809	0.013														
31	-0.787	0.035														
38	-0.814	0.008														
41	-0.814	0.008														
49	-0.840	-0.018														
56	-0.814	0.008														
60	-0.825	-0.003														
65	-0.835	-0.013														
71	-0.826	-0.004														
77	-0.847	-0.025														
83	-0.839	-0.017														
89	-0.843	-0.022														
97	-0.839	-0.017														
	-0.822															

&&Ghosh et al., 2006 paleotemperature equation
**Guo et al., 2009 equation, converted to scale of Dennis et al., 2011
##Dennis and Schrag 2010 equation, converted to scale of Dennis et al., 2011
^^Henkes et al. (2013) mollusk-specific equation, native to scale of Dennis et al., 2011

Corrections for d13C and d18O

UU Carrara		
mean	2.159	-1.905
stdev	0.012	0.036
accepted	2.05	-1.85
correction	-0.11	0.055
NBS-19		
mean	2.030	-2.236
accepted	1.95	-2.19
correction	-0.080	0.046
mean correct	-0.095	0.050
102-GC-AZ01		
mean	0.462	-14.439
stdev	0.060	0.073

"Ghosh Scale" correction scheme.

HG Slope	HG Interce	HG Stretch	Acid Correction
-0.00186	-0.82183	1.028556	0.081

mean stan 0.014

Fixed Heated Gas Line Correction Scheme

	N	avg	residual	acid correc	std correct	stdev	(caltech)	JHU-Caltech offset	
102-GC-AZ	5	0.580	-0.070	0.661	0.647	0.007	0.574		0.006
2-8-E	4	0.564	-0.078	0.645	0.631	0.014	0.557		0.007
Carrara	6	0.294	-0.058	0.375	0.361	0.007	0.276		0.018
NBS-19	2	0.288	-0.064	0.369	0.355	0.013	0.275		0.013
	17					**0.010**			**0.011** avg

	No Std	Std Corr
Yatria Avg	0.671	0.657
	0.015	0.015

Transfer function to convert data to scale of Dennis et al., 2011.

Empirical Transfer Function

ID	D47 @ d47 = 0	D47 TES	D47 TES w/ 0.092 acid corr	
1000 C Heated Gas	-0.821831581	0.0266	0.0266	exclude from transfer function: cannot convc
UU Carrara	-0.536	0.396	0.407	
NBS-19	-0.542	0.405	0.416	
102-GC-AZ01	-0.258	0.701	0.712	
2-8-E	-0.273	0.69	0.701	
slope		1.0773885	**1.077389**	
intercept		0.981476	**0.992476**	

Nov 2009 mean values of standards (new scale)

	N	D47 mean	D47 stdev
102-GC-AZ	5	0.715	0.008
2-8-E	4	0.698	0.014
Carrara	6	0.415	0.007
NBS-19	2	0.408	0.014
			0.011

Long term values for JHU standards (Jan 2010 - June 2011)

	N	D47 Ghosh w	D47 New v	Stdev (New)
UU Carrara	87	0.355	0.396	0.013
NBS-19	27	0.363	0.405	0.019
102-GC-AZ01	98	0.646	0.701	0.014
2-8-E	8	0.630	0.690	0.011

Dennis et al. 2011 average of four labs

D47 New	
0.395	(Carrara general)
0.392	
0.713	

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