

Supplementary Material for

Continental hydroclimate during the late Paleocene-early Eocene in the central Rockies: insights from sedimentological and geochemical records preserved in the greater Green River Basin, southwestern Wyoming, U.S.A.

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Table S1 and Table S2

Introduction

Table S1 contains all the bulk organic carbon isotope data used in the paper. The samples were collected following the field section as introduced in the “2 Geological background” section in the paper (Figure 2). Methods for collecting and processing the data are described in “3.2 Carbon and hydrogen isotope analysis” in the paper.

Table S2 shows the analyzed external standards used for calibrating our major elements weight percentage measurements of paleosol samples (see “3.4 MAP reconstruction” section in the paper).

Table S1 Measured bulk organic carbon isotope ratios

<i>paleosol</i>			<i>mudstone</i>		
Formation	meter level (m)	$\delta^{13}\text{C}$ (‰)	Formation	meter level (m)	$\delta^{13}\text{C}$ (‰)
Fort Union	208.0	-24.0	Fort Union	0.0	-26.1
Fort Union	208.5	-25.2	Fort Union	3.2	-25.2
Fort Union	212.7	-24.0	Fort Union	44.0	-24.2
Fort Union	214.0	-25.4	Fort Union	53.0	-24.8
Fort Union	218.0	-24.4	Fort Union	158.0	-25.4
Fort Union	219.0	-25.0	Fort Union	170.0	-25.9
Fort Union	270.0	-24.7	Fort Union	170.5	-26.1
Fort Union	271.0	-25.1	Fort Union	171.5	-26.0
Fort Union	285.5	-23.7	Fort Union	176.0	-25.9
Fort Union	286.5	-23.2	Fort Union	181.0	-24.7
Fort Union	287.0	-24.6	Fort Union	183.5	-25.9
Fort Union	288.5	-24.7	Fort Union	185.0	-25.5
Fort Union	289.0	-24.9	Fort Union	207.5	-24.7
Fort Union	291.5	-24.7	Fort Union	211.3	-25.8
Fort Union	293.0	-24.7	Fort Union	212.0	-25.2
Fort Union	293.5	-25.3	Fort Union	215.0	-22.8
Fort Union	298.0	-25.2	Fort Union	215.5	-25.9
Fort Union	348.0	-26.0	Fort Union	220.0	-25.7
Fort Union	365.5	-25.5	Fort Union	221.0	-24.7
Fort Union	367.0	-25.4	Fort Union	221.8	-24.8
Fort Union	367.5	-25.1	Fort Union	222.5	-24.3
Fort Union	405.2	-24.7	Fort Union	271.5	-24.8
Fort Union	406.0	-24.8	Fort Union	278.0	-22.9
Fort Union	406.8	-24.8	Fort Union	279.0	-23.1
Fort Union	445.5	-24.8	Fort Union	279.5	-22.8
Fort Union	446.5	-24.8	Fort Union	282.2	-24.8
Fort Union	447.0	-25.0	Fort Union	283.0	-25.1
Fort Union	447.5	-25.6	Fort Union	284.5	-24.3
Fort Union	455.5	-24.8	Fort Union	328.0	-24.6
Fort Union	456.0	-26.3	Fort Union	345.5	-23.0
Fort Union	467.0	-25.7	Fort Union	346.0	-24.8
Fort Union	467.5	-25.5	Fort Union	349.3	-24.3
Fort Union	486.0	-24.9	Fort Union	369.0	-25.1

<i>paleosol</i>			<i>mudstone</i>		
Formation	meter level (m)	$\delta^{13}\text{C}$ (‰)	Formation	meter level (m)	$\delta^{13}\text{C}$ (‰)
Fort Union	487.0	-25.6	Fort Union	369.5	-23.1
Fort Union	496.0	-23.8	Fort Union	426.5	-24.7
Fort Union	498.0	-26.0	Fort Union	448.0	-23.9
Fort Union	570.0	-23.7	Fort Union	448.5	-23.9
Fort Union	572.5	-24.7	Fort Union	449.5	-25.2
Fort Union	573.0	-26.5	Fort Union	450.0	-24.2
Fort Union	573.5	-25.4	Fort Union	451.0	-25.2
Fort Union	606.5	-25.1	Fort Union	457.5	-23.5
Fort Union	607.0	-26.0	Fort Union	459.0	-24.1
Fort Union	609.0	-24.5	Fort Union	460.5	-24.6
Wasatch	1.0	-25.3	Fort Union	484.0	-23.1
Wasatch	2.0	-26.8	Fort Union	485.0	-25.4
Wasatch	6.0	-25.6	Fort Union	485.5	-23.9
Wasatch	6.5	-25.3	Fort Union	489.0	-23.7
Wasatch	7.0	-26.3	Fort Union	490.0	-25.0
Wasatch	8.0	-25.1	Fort Union	491.5	-25.2
Wasatch	12.0	-25.1	Fort Union	494.7	-25.4
Wasatch	12.5	-25.1	Fort Union	501.5	-23.0
Wasatch	14.0	-26.5	Fort Union	504.5	-23.9
Wasatch	14.5	-24.5	Fort Union	506.0	-23.1
Wasatch	15.0	-25.6	Fort Union	530.5	-23.6
Wasatch	17.5	-25.9	Fort Union	531.0	-23.8
Wasatch	18.0	-25.1	Fort Union	531.5	-24.4
Wasatch	18.5	-26.2	Fort Union	574.0	-23.6
Wasatch	19.0	-25.9	Fort Union	574.8	-23.2
Wasatch	19.5	-25.8	Fort Union	612.5	-24.6
Wasatch	68.8	-25.0	Fort Union	613.3	-24.3
Wasatch	72.0	-28.5	Fort Union	614.0	-24.4
Wasatch	72.5	-25.7	Wasatch	10.5	-25.7
Wasatch	73.3	-26.7	Wasatch	23.5	-25.4
Wasatch	74.8	-26.2	Wasatch	59.2	-26.5
Wasatch	75.5	-25.9	Wasatch	68.8	-24.9
Wasatch	77.0	-26.3	Wasatch	69.5	-25.0
Wasatch	77.7	-25.6	Wasatch	70.3	-25.0
Wasatch	78.5	-25.7	Wasatch	71.0	-26.2

<i>paleosol</i>			<i>mudstone</i>		
Formation	meter level (m)	$\delta^{13}\text{C}$ (‰)	Formation	meter level (m)	$\delta^{13}\text{C}$ (‰)
Wasatch	79.2	-25.8	Wasatch	71.8	-25.8
Wasatch	79.5	-28.2	Wasatch	73.5	-25.5
Wasatch	79.8	-28.3	Wasatch	73.8	-25.8
Wasatch	82.3	-27.0	Wasatch	74.0	-25.8
Wasatch	83.8	-28.3	Wasatch	74.3	-25.8
Wasatch	83.8	-25.1	Wasatch	74.5	-26.4
Wasatch	84.0	-28.3	Wasatch	74.8	-26.5
Wasatch	86.3	-26.0	Wasatch	75.0	-25.8
Wasatch	86.5	-26.3	Wasatch	75.3	-26.0
Wasatch	86.8	-26.0	Wasatch	75.5	-26.5
Wasatch	87.0	-28.3	Wasatch	75.8	-25.7
Wasatch	87.5	-28.0	Wasatch	76.0	-27.2
Wasatch	87.8	-25.0	Wasatch	76.3	-25.9
Wasatch	88.3	-26.4	Wasatch	76.5	-25.3
Wasatch	90.5	-27.1	Wasatch	77.0	-26.3
Wasatch	90.5	-28.2	Wasatch	77.3	-25.8
Wasatch	91.3	-27.5	Wasatch	77.8	-26.1
Wasatch	92.0	-27.3	Wasatch	78.5	-26.0
Wasatch	93.0	-27.5	Wasatch	78.8	-26.2
Wasatch	94.3	-26.1	Wasatch	78.9	-22.5
Wasatch	94.5	-25.3	Wasatch	80.0	-25.4
Wasatch	94.8	-26.0	Wasatch	80.3	-25.3
Wasatch	97.3	-25.1	Wasatch	80.5	-25.4
Wasatch	98.8	-25.0	Wasatch	82.3	-25.5
Wasatch	99.0	-24.0	Wasatch	82.5	-26.3
Wasatch	101.5	-27.6	Wasatch	82.8	-26.1
Wasatch	106.5	-26.8	Wasatch	83.0	-25.3
Wasatch	107.9	-25.1	Wasatch	83.3	-26.2
Wasatch	109.6	-25.2	Wasatch	83.5	-26.5
Wasatch	110.3	-25.8	Wasatch	84.3	-26.4
Wasatch	111.8	-27.8	Wasatch	84.5	-26.6
Wasatch	115.4	-28.7	Wasatch	85.3	-26.5
Wasatch	115.7	-27.5	Wasatch	86.7	-26.5
Wasatch	117.2	-27.5	Wasatch	87.3	-24.6
Wasatch	120.1	-25.8	Wasatch	89.5	-27.2

<i>paleosol</i>			<i>mudstone</i>		
Formation	meter level (m)	$\delta^{13}\text{C}$ (‰)	Formation	meter level (m)	$\delta^{13}\text{C}$ (‰)
Wasatch	120.8	-25.5	Wasatch	90.0	-26.5
Wasatch	121.6	-27.1	Wasatch	90.9	-26.2
Wasatch	122.3	-25.0	Wasatch	91.5	-26.7
Wasatch	122.5	-27.9	Wasatch	91.8	-26.9
Wasatch	122.8	-29.4	Wasatch	92.3	-26.1
Wasatch	123.0	-25.5	Wasatch	92.5	-25.2
Wasatch	123.8	-25.3	Wasatch	92.8	-26.0
Wasatch	125.8	-24.7	Wasatch	93.3	-24.9
Wasatch	126.5	-25.5	Wasatch	93.5	-26.3
Wasatch	127.2	-25.0	Wasatch	93.8	-25.4
Wasatch	128.8	-26.4	Wasatch	94.8	-24.8
Wasatch	131.3	-24.7	Wasatch	95.5	-26.0
Wasatch	131.8	-26.2	Wasatch	96.3	-24.9
Wasatch	132.0	-26.3	Wasatch	97.0	-24.5
Wasatch	132.3	-24.6	Wasatch	97.7	-25.7
Wasatch	132.5	-27.8	Wasatch	98.0	-27.2
Wasatch	133.0	-28.4	Wasatch	98.3	-24.0
Wasatch	138.5	-27.8	Wasatch	98.5	-26.7
Wasatch	138.8	-27.3	Wasatch	99.3	-25.5
Wasatch	139.0	-28.1	Wasatch	99.5	-25.8
Wasatch	140.8	-27.2	Wasatch	100.3	-24.9
Wasatch	145.7	-25.5	Wasatch	100.7	-25.2
Wasatch	147.7	-25.5	Wasatch	100.8	-25.4
Wasatch	148.3	-25.9	Wasatch	101.0	-25.0
Wasatch	164.2	-26.0	Wasatch	101.3	-23.6
Wasatch	165.0	-26.0	Wasatch	101.8	-25.5
Wasatch	165.8	-26.8	Wasatch	105.7	-22.9
Wasatch	167.3	-26.8	Wasatch	106.5	-26.2
Wasatch	168.0	-27.3	Wasatch	106.8	-25.2
Wasatch	168.8	-27.3	Wasatch	109.8	-26.1
Wasatch	169.5	-25.1	Wasatch	110.0	-26.5
Wasatch	177.0	-26.0	Wasatch	110.3	-26.3
Wasatch	186.2	-26.5	Wasatch	112.0	-26.5
Wasatch	194.5	-24.4	Wasatch	112.3	-26.4
Wasatch	196.7	-25.8	Wasatch	112.5	-26.6

<i>paleosol</i>			<i>mudstone</i>		
Formation	meter level (m)	$\delta^{13}\text{C}$ (‰)	Formation	meter level (m)	$\delta^{13}\text{C}$ (‰)
Wasatch	197.5	-27.0	Wasatch	112.8	-25.8
Wasatch	201.8	-25.5	Wasatch	113.0	-26.9
Wasatch	202.5	-26.0	Wasatch	113.3	-26.8
Wasatch	203.2	-26.8	Wasatch	115.9	-26.4
Wasatch	204.0	-26.5	Wasatch	116.2	-26.7
Wasatch	205.5	-26.8	Wasatch	116.4	-26.4
Wasatch	207.0	-27.3	Wasatch	116.7	-26.1
Wasatch	213.5	-25.4	Wasatch	116.9	-25.3
Wasatch	214.3	-25.8	Wasatch	117.7	-26.4
Wasatch	220.0	-25.4	Wasatch	118.4	-25.1
Wasatch	220.8	-25.4	Wasatch	118.9	-26.2
Wasatch	243.8	-27.0	Wasatch	122.0	-25.0
Wasatch	245.3	-26.2	Wasatch	123.1	-25.9
Wasatch	246.8	-25.8	Wasatch	123.8	-27.0
Wasatch	302.0	-25.1	Wasatch	124.0	-26.1
Wasatch	302.7	-26.4	Wasatch	124.3	-26.2
Wasatch	303.5	-24.9	Wasatch	124.8	-25.4
Wasatch	304.2	-26.1	Wasatch	125.0	-25.8
Wasatch	305.0	-26.7	Wasatch	125.3	-25.9
Wasatch	305.8	-25.0	Wasatch	125.5	-26.3
Wasatch	306.5	-25.7	Wasatch	125.9	-25.8
Wasatch	307.3	-26.1	Wasatch	126.8	-25.7
Wasatch	308.0	-25.1	Wasatch	127.0	-25.5
Wasatch	308.7	-27.0	Wasatch	127.3	-25.5
Wasatch	309.5	-24.9	Wasatch	127.5	-26.4
Wasatch	311.7	-26.6	Wasatch	132.8	-26.6
Wasatch	312.5	-26.2	Wasatch	135.2	-24.2
Wasatch	313.3	-26.5	Wasatch	137.5	-25.8
Wasatch	314.0	-26.2	Wasatch	138.3	-26.4
Wasatch	328.0	-26.3	Wasatch	139.7	-24.5
Wasatch	328.3	-26.1	Wasatch	140.3	-24.6
Wasatch	328.7	-26.4	Wasatch	141.3	-25.7
Wasatch	329.1	-26.6	Wasatch	153.0	-26.5
Wasatch	329.5	-25.7	Wasatch	155.0	-26.7
Wasatch	365.0	-25.6	Wasatch	174.0	-26.9

<i>paleosol</i>			<i>mudstone</i>		
Formation	meter level (m)	$\delta^{13}\text{C}$ (‰)	Formation	meter level (m)	$\delta^{13}\text{C}$ (‰)
Wasatch	366.0	-26.4	Wasatch	176.3	-24.4
Wasatch	366.5	-27.4	Wasatch	187.0	-25.1
Wasatch	367.0	-26.1	Wasatch	187.8	-25.1
Wasatch	367.5	-25.9	Wasatch	188.5	-25.4
Wasatch	368.0	-25.9	Wasatch	190.0	-26.0
Wasatch	390.5	-27.4	Wasatch	190.7	-25.4
Wasatch	391.0	-25.9	Wasatch	191.5	-25.9
Wasatch	391.5	-25.5	Wasatch	193.0	-24.9
Wasatch	392.5	-25.9	Wasatch	193.7	-24.4
Wasatch	393.5	-25.4	Wasatch	209.0	-26.5
Wasatch	404.0	-26.6	Wasatch	209.8	-23.4
Wasatch	405.0	-26.0	Wasatch	210.5	-25.2
Wasatch	406.0	-26.4	Wasatch	212.0	-24.7
Wasatch	406.5	-26.4	Wasatch	215.8	-25.0
Wasatch	407.0	-26.1	Wasatch	217.3	-24.9
Wasatch	407.5	-25.9	Wasatch	222.3	-26.0
Wasatch	408.0	-26.8	Wasatch	288.0	-24.0
Wasatch	408.5	-26.3	Wasatch	311.0	-24.7
Wasatch	410.0	-26.1	Wasatch	326.5	-24.2
Wasatch	410.5	-27.2	Wasatch	326.9	-25.8
Wasatch	416.0	-25.7	Wasatch	327.3	-25.9
Wasatch	424.0	-25.9	Wasatch	330.2	-26.9
Wasatch	424.5	-26.5	Wasatch	378.5	-24.3
Wasatch	425.0	-26.3	Wasatch	398.0	-23.8
Wasatch	426.0	-27.0	Wasatch	399.0	-24.8
Wasatch	427.0	-25.7	Wasatch	401.0	-24.7
Wasatch	427.5	-24.8	Wasatch	403.5	-23.3
Wasatch	428.0	-25.0	Wasatch	411.0	-23.6
Wasatch	429.0	-26.1	Wasatch	440.5	-24.7
Wasatch	446.0	-27.3	Wasatch	461.5	-25.6
Wasatch	448.0	-27.1	Wasatch	473.0	-24.0
Wasatch	448.5	-27.1	Wasatch	474.5	-26.2
Wasatch	449.0	-27.2	Wasatch	487.0	-26.8
Wasatch	449.5	-27.3	Wasatch	490.0	-24.5
Wasatch	450.0	-27.0	Wasatch	492.5	-25.5

<i>paleosol</i>			<i>mudstone</i>		
Formation	meter level (m)	$\delta^{13}\text{C}$ (‰)	Formation	meter level (m)	$\delta^{13}\text{C}$ (‰)
Wasatch	456.5	-26.0	Wasatch	493.5	-25.6
Wasatch	461.0	-27.0	Wasatch	496.0	-27.0
Wasatch	468.5	-26.5	Wasatch	499.0	-26.5
Wasatch	469.5	-26.0	Wasatch	507.0	-25.6
Wasatch	471.0	-25.1	Wasatch	548.2	-23.5
Wasatch	491.0	-27.0	Wasatch	549.0	-26.3
Wasatch	491.5	-27.5	Wasatch	550.5	-24.2
Wasatch	495.0	-25.3	Wasatch	555.0	-25.5
Wasatch	495.5	-28.5	Wasatch	556.5	-25.8
Wasatch	500.0	-26.4	Wasatch	562.5	-23.0
Wasatch	501.0	-26.7	Wasatch	563.2	-24.1
Wasatch	564.0	-26.5	Wasatch	565.5	-26.6
Wasatch	573.0	-25.3	Wasatch	571.5	-26.8
Wasatch	574.5	-25.5	Wasatch	579.0	-26.0
Wasatch	576.0	-27.4	Wasatch	582.0	-25.5
Wasatch	580.5	-26.2	Wasatch	583.5	-25.1
Wasatch	585.0	-27.9	Wasatch	584.3	-25.3
Wasatch	586.5	-26.6	Wasatch	588.8	-26.2
Wasatch	637.2	-26.8	Wasatch	589.5	-26.6
Wasatch	642.5	-26.8	Wasatch	590.3	-25.5
Wasatch	643.2	-26.9	Wasatch	591.8	-26.3
			Wasatch	592.5	-25.6
			Wasatch	627.0	-26.9
			Wasatch	628.5	-26.5
			Wasatch	631.5	-25.7
			Wasatch	636.5	-25.6
			Wasatch	638.0	-26.6
			Wasatch	638.7	-26.5
			Wasatch	639.5	-26.9
			Wasatch	640.0	-26.9
			Wasatch	641.0	-26.9
			Wasatch	644.0	-27.0
			Wasatch	645.5	-27.0

Table S2 Analyzed external standards used for calibration curve in Shimadzu EDX-7000 analyses of shales

	<i>Certified/Preferred Values^a</i>			<i>Average (N = 5)^b</i>						<i>Standard Deviation (N = 5)^c</i>			<i>RSD (%)^d</i>		
	SDO-I	SBC-I	SGR-I	SDO-I	% error	SBC-I	% error	SGR-I	% error	SDO-I	SBC-I	SGR-I	SDO-I	SBC-I	SGR-I
Na ₂ O	0.38	0.15	2.99	0.12	69.21	0.18	17.33	0.41	86.25	0.03	0.03	0.03	22.22	14.20	7.06
MgO	1.54	2.6	4.44	1.34	13.31	2.56	0.83	4.45	0.29	0.17	0.19	0.21	13.03	7.45	4.72
Al ₂ O ₃	12.27	21	6.52	12.49	1.80	20.92	1.27	6.28	3.68	0.02	0.01	0.02	0.13	0.06	0.33
SiO ₂	49.28	47.64	28.2	48.87	0.83	47.73	0.31	29.26	3.75	0.27	0.26	0.21	0.55	0.55	0.70
K ₂ O	3.35	3.45	1.66	3.27	2.39	3.54	5.66	1.71	2.89	0.04	0.04	0.03	1.16	1.07	1.70
CaO	1.05	2.95	8.38	1.46	39.05	2.63	3.87	8.35	0.32	0.001	0.001	0.000	0.068	0.038	0.000
TiO ₂	0.71	0.855	0.253	0.72	0.70	0.85	2.37	0.26	1.98	0.02	0.03	0.01	3.36	3.30	4.65
Fe ₂ O ₃	9.34	9.71	3.03	9.25	0.99	9.79	2.61	3.05	0.59	0.02	0.02	0.01	0.26	0.25	0.43

^aUSGS standards SDO-I (Devonian Ohio Shale), SBC-I (Brush Creek Shale), and SGR-I (Green River Shale) were used.

^bAccuracy: All of the results from the different runs are averaged here and their accuracy relative to their standard reference values is reported as % error. The percentage error for each element is calculated:

$$\%error = \frac{\text{Difference between measured and certified concentration}}{\text{Certified concentration of the element}} \times 100$$

^cStandard Deviation: The standard deviation is calculated, where \bar{x} is the average concentration, x is the element concentration, and n is the number of measurements, as follows:

$$\sigma = \sqrt{\frac{\sum (x - \bar{x})^2}{n - 1}}$$

^dPrecision: the precision of a sample with respect to each element is represented by the relative standard deviation (RSD), calculated as follows:

$$RSD(\%) = \frac{100\sigma}{\bar{x}}$$