

SUPPLEMENTARY INFORMATION

Supplementary Table 1: Characteristics of all analytical sessions

Session	# Stds	K_{cor} (Stds) ¹	MSWD (Stds) ²	# Samples	notes ³
1	6	0.025	0.68	7	C1
2	8	0.022	1.40	7	
3	8	0.023	1.50	15	
4	10	0.022	0.80	22	
5	10	0.030	0.89	10	C5
6	11	0.027	3.30	15	C6
7	12	0.022	0.74	17	C7
8	9	0.023	3.50	7	
9	8	0.028	0.47	12	
10	6	0.024	0.68	5	

¹ Average QSA correction parameter (corrected $^{12}\text{C}/\text{Cs}^+$; Slodzian et al., 2004) for K-1 standards in the session. Approximately double the relative correction to $^{13}\text{C}/^{12}\text{C}$.

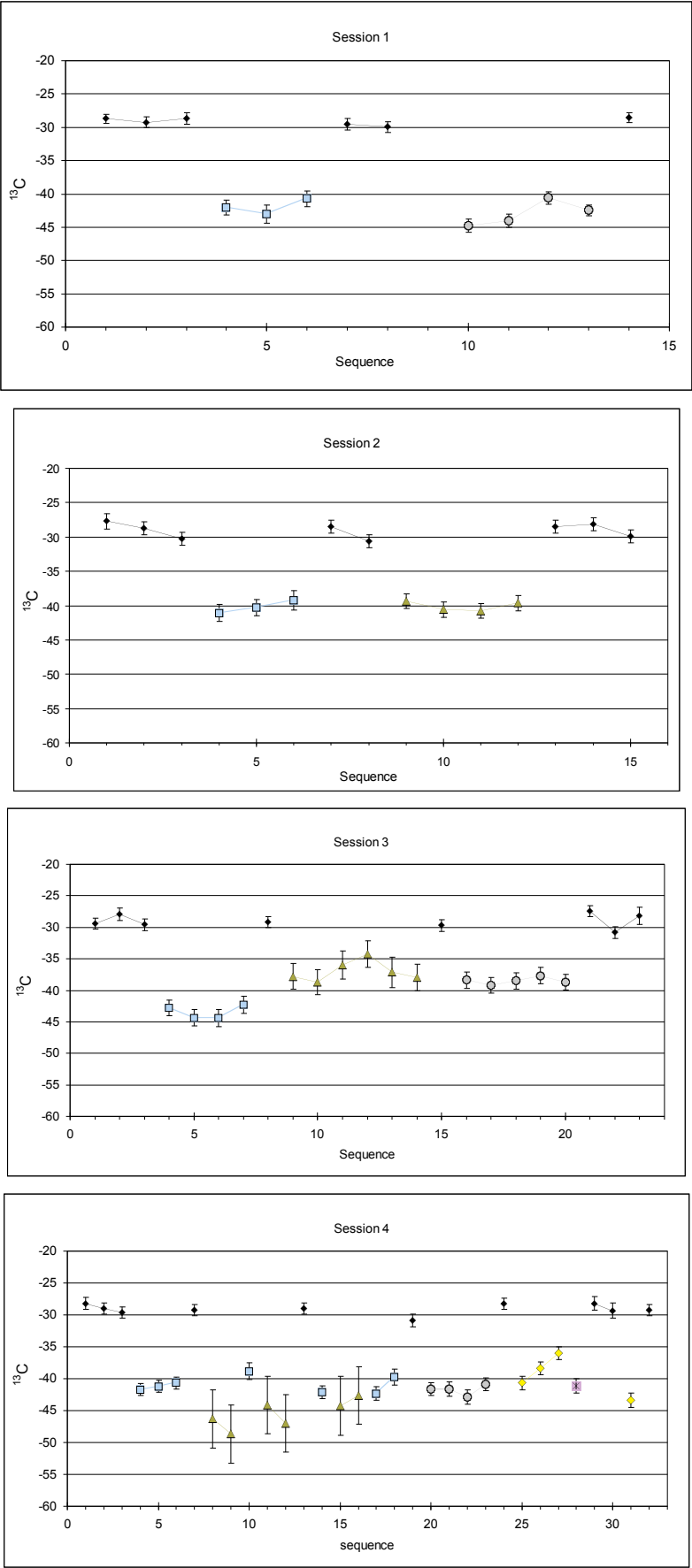
² Mean Squared Weighted Deviations (MSWD) for the linear regression of K-1 data.

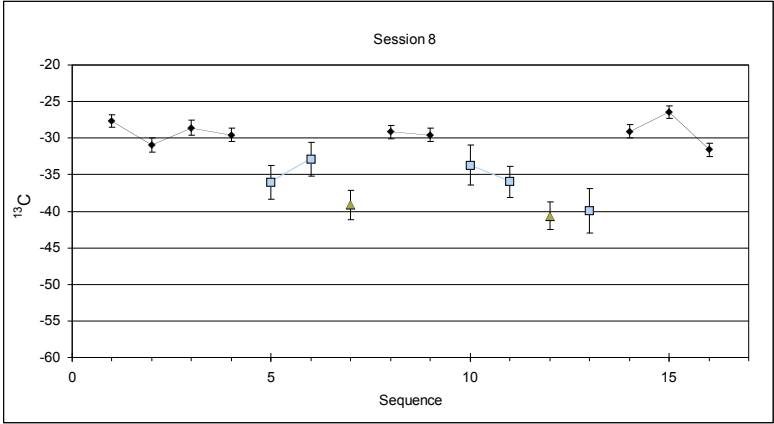
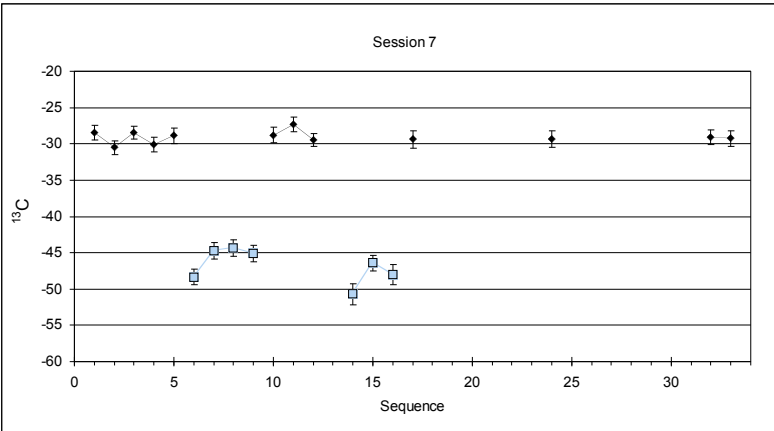
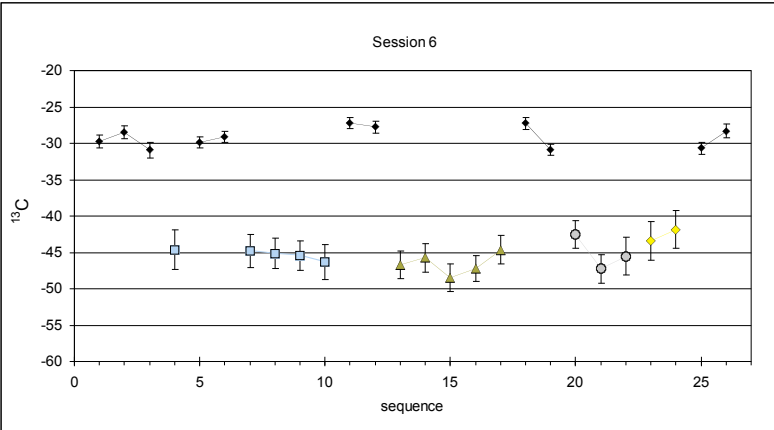
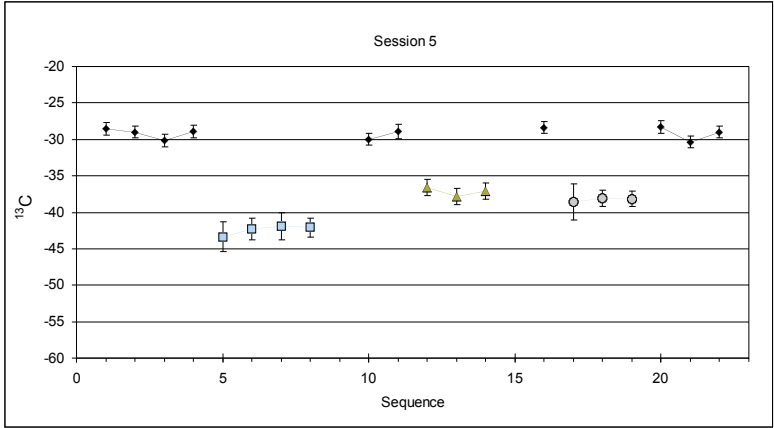
³C1: One sample analysis that appears to be affected by charging of an adjacent matrix grain was omitted.

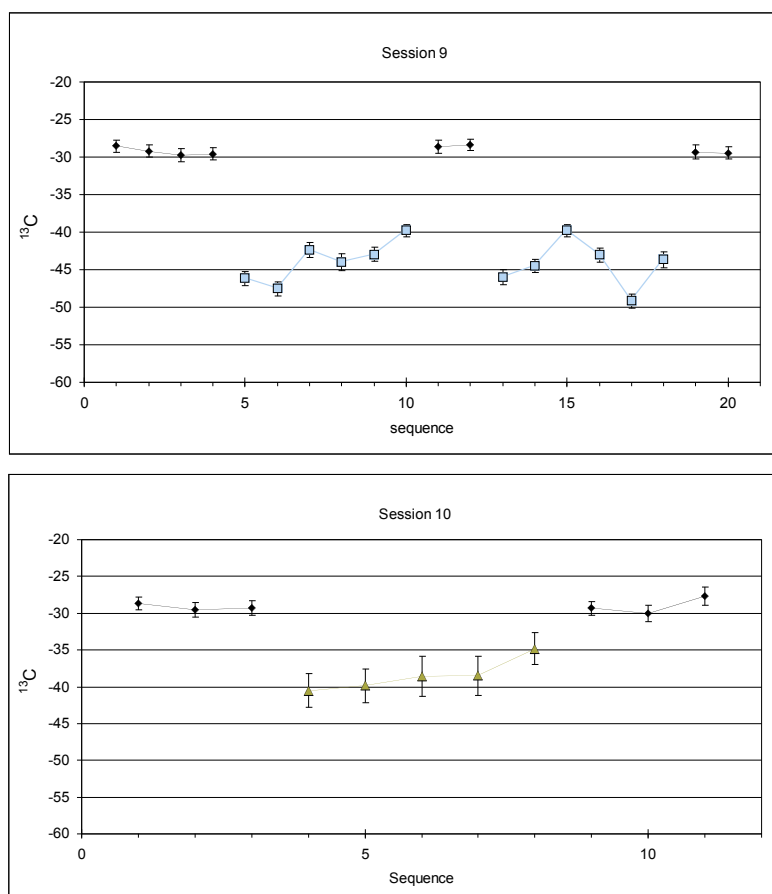
³C5: Two mid-session K-1 analyses (not counted in the 10) with abnormal focus conditions and low secondary ion count rates were omitted.

³C6: One leading and three trailing K-1 analyses were omitted; sample analyses were fully bracketed by the remaining standards.

³C7: Data from re-visited sites on the standard are omitted (see Fletcher et al., in press). There were no revisited sample analyses.







Supplementary Figure 1: Data, plotted in analytical sequence. The data are normalized to the reference $\delta^{13}\text{C}$ for K-1 through the linear regression of K-1 data (black diamonds) in each session, but (unlike Supplementary Table 2) without correction for the calibration drift that arises predominantly from aging of the $^{12}\text{C}^-$ electron multiplier. K-1 points are shown with internal 1σ precision only. Sample data are shown with cumulative uncertainties as described above and listed in Supplementary Table 1. Separate samples analyzed within sessions are shown by different symbols, but these do not correlate between sessions. Missing data from Session 7 are for an unrelated project.

Supplementary Table 2: Carbon isotope data for samples. Individual analyses are cross-referenced with Supplementary Figure 1 by session and sequence numbers. Data are corrected for calibration drift, unlike Supplementary Figure 1

Analysis ¹	Drill hole	¹² C- Kcps ²	K _{cor} ³	<i>p</i> ⁴	±	δ ¹³ C _{PDB}	±	Sess.	Seq.
<i>Kerogen</i>									
NM113C#1	WRL-1	315	0.025	0.98	0.02	-42.6	1.9	6	20
NM113C#3	WRL-1	341	0.027	0.88	0.03	-47.2	2.0	6	21
NM113C#6	WRL-1	294	0.023	0.86	0.06	-45.5	2.6	6	22
NM113D#2	WRL-1	173	0.014	0.95	0.02	-41.9	2.6	6	24
NM113D#3	WRL-1	193	0.015	0.83	0.03	-43.4	2.6	6	23
NM113A#1	WRL-1	141	0.015	0.89	0.04	-44.6	2.7	6	4
NM113A#2	WRL-1	238	0.019	0.93	0.03	-44.8	2.3	6	7
NM113A#4	WRL-1	270	0.022	0.96	0.02	-45.1	2.1	6	8
NM113A#8	WRL-1	280	0.023	0.96	0.02	-45.4	2.1	6	9
NM113A#10	WRL-1	317	0.026	0.83	0.05	-46.3	2.4	6	10
NM111C#1	DDH186	255	0.031	0.98	0.02	-37.9	1.1	5	13
NM111C#2	DDH186	260	0.031	0.96	0.02	-36.6	1.1	5	12
NM111C#3	DDH186	251	0.030	0.96	0.02	-37.1	1.1	5	14
NM111D#1	DDH186	264	0.031	0.80	0.08	-38.6	2.5	5	17
NM111D#2	DDH186	251	0.030	0.94	0.02	-38.1	1.2	5	18
NM111D#3	DDH186	263	0.031	0.96	0.02	-38.2	1.1	5	19
NM111A#1	DDH186	193	0.023	0.88	0.04	-43.3	2.0	5	5
NM111A#3	DDH186	206	0.025	0.90	0.03	-42.3	1.5	5	6
NM111A#4	DDH186	213	0.026	0.85	0.05	-41.9	1.8	5	7
NM111A#5	DDH186	214	0.026	0.94	0.02	-42.1	1.3	5	8
<i>Matrix pyrobitumen</i>									
NM109B1#1	FVG1	487	0.021			-42.1	1.1	1	4
NM112B2#1	WRL-1	438	0.026			-41.6	1.0	4	20
NM112B2#2	WRL-1	468	0.028			-41.6	1.1	4	21
NM112B2#3	WRL-1	472	0.028			-42.9	1.1	4	22
NM112B2#4	WRL-1	455	0.027			-40.9	1.0	4	23
NM112A1#1	WRL-1	375	0.024			-41.7	1.0	4	4
NM112A1#2	WRL-1	382	0.024			-41.2	1.0	4	5
NM112A1#3	WRL-1	355	0.022			-40.7	1.0	4	6
NM112A2#1	WRL-1	349	0.022	0.73	0.12	-46.3	4.6	4	8
NM112A2#2	WRL-1	349	0.021	0.45	0.07	-48.7	4.6	4	9
NM112A2#3	WRL-1	349	0.021	0.75	0.12	-44.1	4.5	4	11
NM112A2#4	WRL-1	349	0.021	0.53	0.09	-47.0	4.5	4	12
NM112A2#5	WRL-1	294	0.018	0.97	0.02	-38.8	1.3	4	10
NM112A2#5r	WRL-1	284	0.017			-39.8	1.3	4	18
NM112A3#1	WRL-1	427	0.026			-42.1	1.0	4	14
NM112A3#2	WRL-1	349	0.021	0.71	0.11	-44.3	4.6	4	15
NM112A3#3	WRL-1	349	0.021	0.78	0.12	-42.6	4.5	4	16
NM112A3#4	WRL-1	384	0.023			-42.4	1.1	4	17
NM112C#5	WRL-1	302	0.032	0.99	0.01	-46.2	0.9	9	5
NM112C#6	WRL-1	324	0.034			-47.5	0.9	9	6
NM112C#7	WRL-1	253	0.026			-42.3	1.0	9	7
NM112C#8	WRL-1	260	0.027	0.97	0.02	-44.0	1.1	9	8
NM112C#9	WRL-1	267	0.027			-43.0	0.9	9	9
NM112C#10	WRL-1	276	0.028			-39.8	0.9	9	10
NM112C#11	WRL-1	340	0.035			-46.0	1.0	9	13
NM112C#12	WRL-1	286	0.029			-44.5	0.8	9	14
NM112C#13	WRL-1	281	0.029			-39.8	0.8	9	15
NM112C#14	WRL-1	280	0.029			-43.1	0.9	9	16
NM112C#15	WRL-1	321	0.033	0.98	0.01	-49.2	1.0	9	17
NM112C#16	WRL-1	315	0.033			-43.6	1.1	9	18
NM112C1#1	WRL-1	493	0.029			-40.7	1.1	4	25
NM112C1#2	WRL-1	437	0.026			-38.4	1.0	4	26
NM112C1#3	WRL-1	451	0.027			-36.0	1.0	4	27

NM112C1#4	WRL-1	494	0.029	-43.4	1.2	4	31
NM113B#1	WRL-1	280	0.022	-46.7	2.0	6	13
NM113B#5	WRL-1	277	0.022	-45.7	2.0	6	14
NM113B#7	WRL-1	302	0.024	-48.5	1.9	6	15
NM113B#10	WRL-1	327	0.026	-47.3	1.8	6	16
NM113B#13	WRL-1	285	0.023	-44.6	1.9	6	17
NM109E1#3	DDH186	580	0.024	-44.8	0.9	1	10
NM109E1#4	DDH186	563	0.023	-44.0	1.0	1	11
NM109E2#2	DDH186	554	0.023	-40.6	0.9	1	12
NM109E2#3	DDH186	623	0.026	-42.5	0.8	1	13
NM110A2#1	DDH186	424	0.023	-39.3	1.1	2	9
NM110A2#2	DDH186	421	0.023	-40.6	1.1	2	10
NM110A2#3	DDH186	408	0.023	-40.7	1.1	2	11
NM110A2#4	DDH186	430	0.024	-39.6	1.1	2	12
NM110B1#1	DDH186	298	0.021	-42.3	1.4	3	7
NM110B2#1	DDH186	325	0.023	-42.8	1.2	3	4
NM110B2#2	DDH186	333	0.023	-44.4	1.3	3	5
NM110B2#3	DDH186	302	0.021	-44.4	1.3	3	6
NM110D2#1	DDH186	317	0.022	-38.4	1.3	3	16
NM110D2#3	DDH186	323	0.022	-39.2	1.3	3	17
NM110D2#4	DDH186	319	0.022	-38.5	1.3	3	18
NM110D2#5	DDH186	312	0.022	-37.7	1.3	3	19
NM110D2#6	DDH186	326	0.023	-38.7	1.2	3	20
NM118B#1	DDH186	174	0.022	-48.3	1.1	7	6
NM118B#3	DDH186	218	0.028	-44.8	1.1	7	7
NM118B#4	DDH186	225	0.029	-44.4	1.2	7	8
NM118B#5	DDH186	180	0.024	-50.7	1.4	7	14
NM118B#6	DDH186	195	0.027	-46.4	1.1	7	15
NM118B#7	DDH186	217	0.030	-48.0	1.4	7	16
NM118B#8	DDH186	219	0.029	-45.1	1.2	7	9

Pyrobitumen around radioactive grain

NM109B2#2	FVG1	430	0.018	-43.1	1.4	1	5
NM109B2#4	FVG1	460	0.020	-40.7	1.2	1	6
NM112D1#1	WRL-1	495	0.029	-41.1	1.1	4	28
NM110A1#1	DDH186	382	0.020	-41.1	1.2	2	4
NM110A1#2	DDH186	383	0.021	-40.3	1.2	2	5
NM110A1#3	DDH186	399	0.022	-39.2	1.4	2	6

Vein pyrobitumen

NM118A#1	WRL-1	246	0.029	0.90	0.06	-36.1	2.3	8	5
NM118A#4	WRL-1	232	0.027	0.88	0.07	-32.9	2.4	8	6
NM118A#5	WRL-1	271	0.031	0.93	0.03	-39.1	2.0	8	7
NM118A#7	WRL-1	246	0.028	0.88	0.03	-40.6	1.9	8	12
NM118A#8	WRL-1	252	0.029	0.88	0.08	-33.7	2.8	8	10
NM118A#9	WRL-1	274	0.031	0.92	0.04	-36.0	2.2	8	11
NM118A#10	WRL-1	248	0.028	0.50	0.05	-40.0	3.1	8	13
NM109D#8	WRL-1	80	0.010	0.85	0.05	-38.6	2.7	10	6
NM109D#9	WRL-1	76	0.009	0.82	0.10	-38.5	2.7	10	7
NM109D#10	WRL-1	74	0.009			-40.5	2.3	10	4
NM109D#11	WRL-1	76	0.010			-39.9	2.3	10	5
NM109D#12	WRL-1	82	0.011	0.99	0.01	-34.8	2.2	10	8
NM110C1#1	DDH186	173	0.012			-37.8	2.1	3	9
NM110C1#2	DDH186	187	0.013			-38.7	2.0	3	10
NM110C1#3	DDH186	152	0.011			-36.0	2.2	3	11
NM110C1#4	DDH186	168	0.012			-34.2	2.1	3	12
NM110C1#5	DDH186	180	0.013			-37.1	2.4	3	13
NM110C1#7	DDH186	163	0.011			-37.9	2.1	3	14

¹ Analysis labels NMxxxAy#zr: NMxxx is UWA mount no.; A is a ~3 mm disc in that mount; y is a recorded zone in the disc; z is a grain within the disc or zone; r is a repeat analysis.

² Corrected for coverage and dead-time.

³ Corrected $^{12}\text{C}/^{13}\text{C}^+$, used for QSA correction (Slodzian et al., 2004).

⁴ Coverage (Fletcher et al., in press), listed only when $p \neq 1$.

References

Fletcher, I. R., Kilburn, M. R. & Rasmussen, B. NanoSIMS μm -scale in situ measurement of $^{13}\text{C}/^{12}\text{C}$ in early Precambrian organic matter, with permil precision. *Int. J. Mass Spec.* (in press).

Slodzian, G., Hillion, F., Stadermann, F. J. & Zinner, E. QSA influences on isotopic ratio measurements. *Appl. Surface Sci.* **231-232**, 874-877 (2004).