GSA Data Repository Item 2017343
Lawson, M., Shenton, B.J., Stolper, D.A., Eiler, J.M., Rasbury, E.T., Becker, T.P., Phillips-Lander, C.M., Buono, A.S., Becker, S.P., Pottorf, R., Gray, G.G., Yurewicz, D., and Gournay, J., 2017, Deciphering the diagenetic history of the El Abra Formation of Eastern Mexico using reordered clumped isotope temperatures and U-Pb dating: GSA Bulletin, https://doi.org/10.1130/B31656.1.

DATA REPOSITORY

Figure DR1. Slab (approximately 1.5 x 1.5 cm) of CMEX3. The limestone host is at the bottom and the veins that were the focus of this study are at the top. The first generation of veins is radiaxial cement that is low in the REE and U and high in Sr and Pb. Note that above this vein is a scalloped brown layer that is high in La, U, and Pb. This vein is cut by small veins that are lower in all of the elements than the radiaxial vein. These small veins appear to terminate at the overlying blocky calcite and have similar counts for all of the mapped elements suggesting that the veins could be related. The scratches on the two small veins are an attempt to sample for ID TIMS. This sampling did not yield enough Pb to get an ID TIMS analysis.

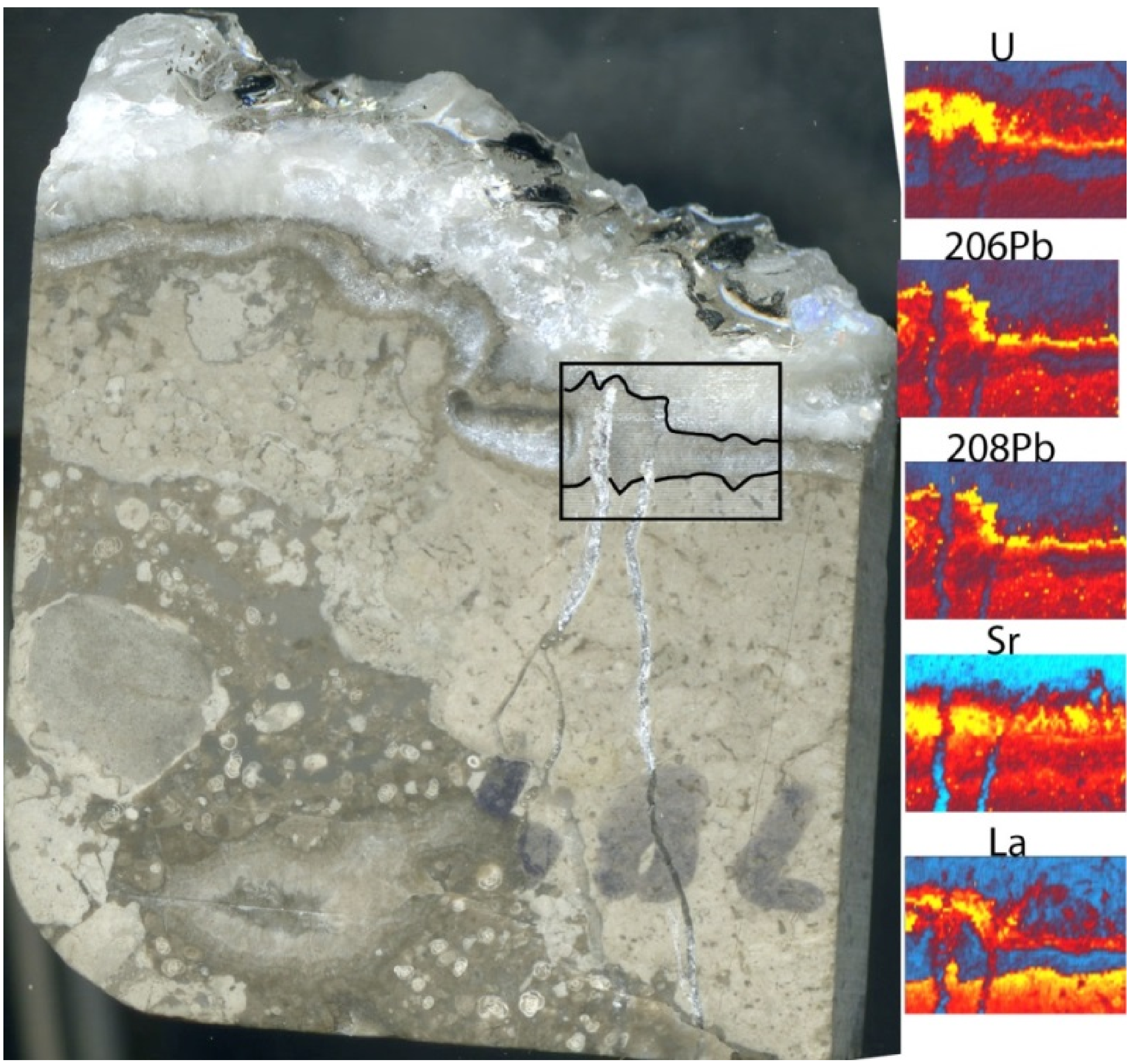

Figure DR2. Inverse isochron plot created in IsoExcel (Ludwig, 2012). The data are from LA ICP-MS referenced to a carbonate standard.

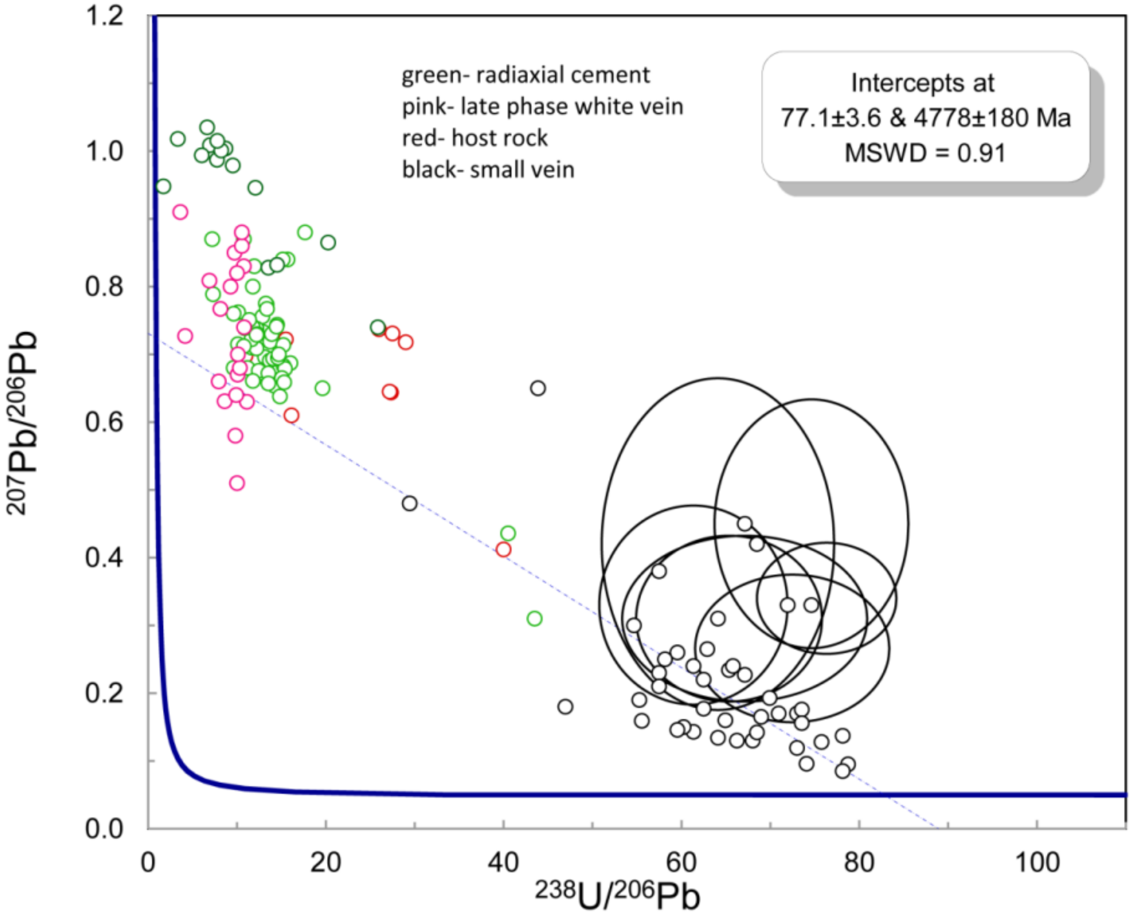

Figure DR3. The opposite side of the slab shown in Figure DR1. Spots are plotted and were analyzed from top to bottom. The best estimate of the age of the small veins is shown in the inverse isochron which was created in IsoExcel (Ludwig, 2012).

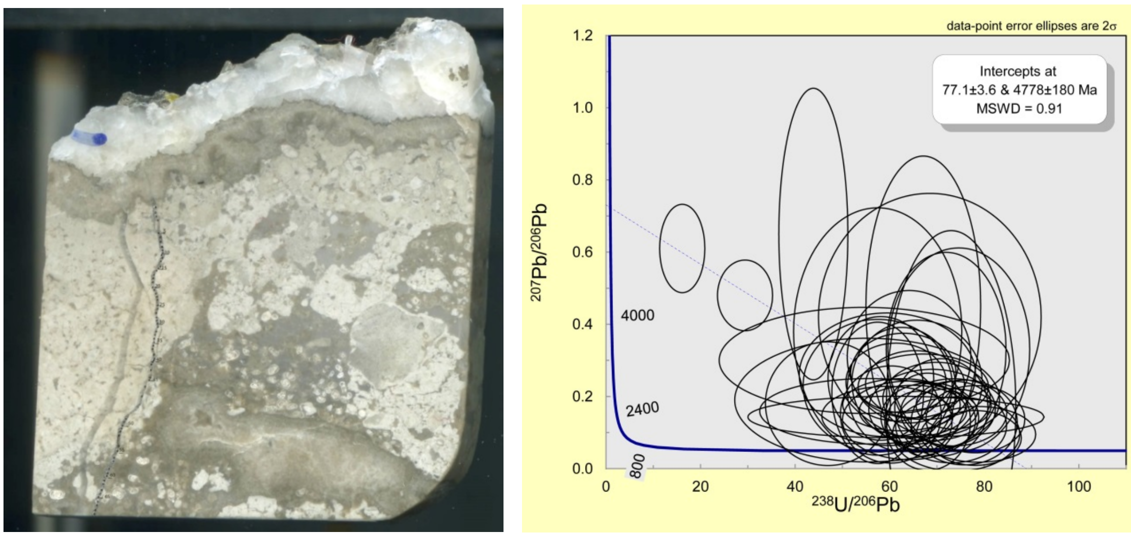

Figure DR4: Ages of individual spots based on taking the ages from Iolite and correcting to the expected age of the natural carbonate standard. These samples have similar amounts of common Pb making this calculation reasonable. Although the calculation is somewhat ad hoc, this diagram shows that the data are very coherent. The points that do not fall on the average line are those with the lower U/Pb. Graph from IsoExcel (Ludwig, 2012).

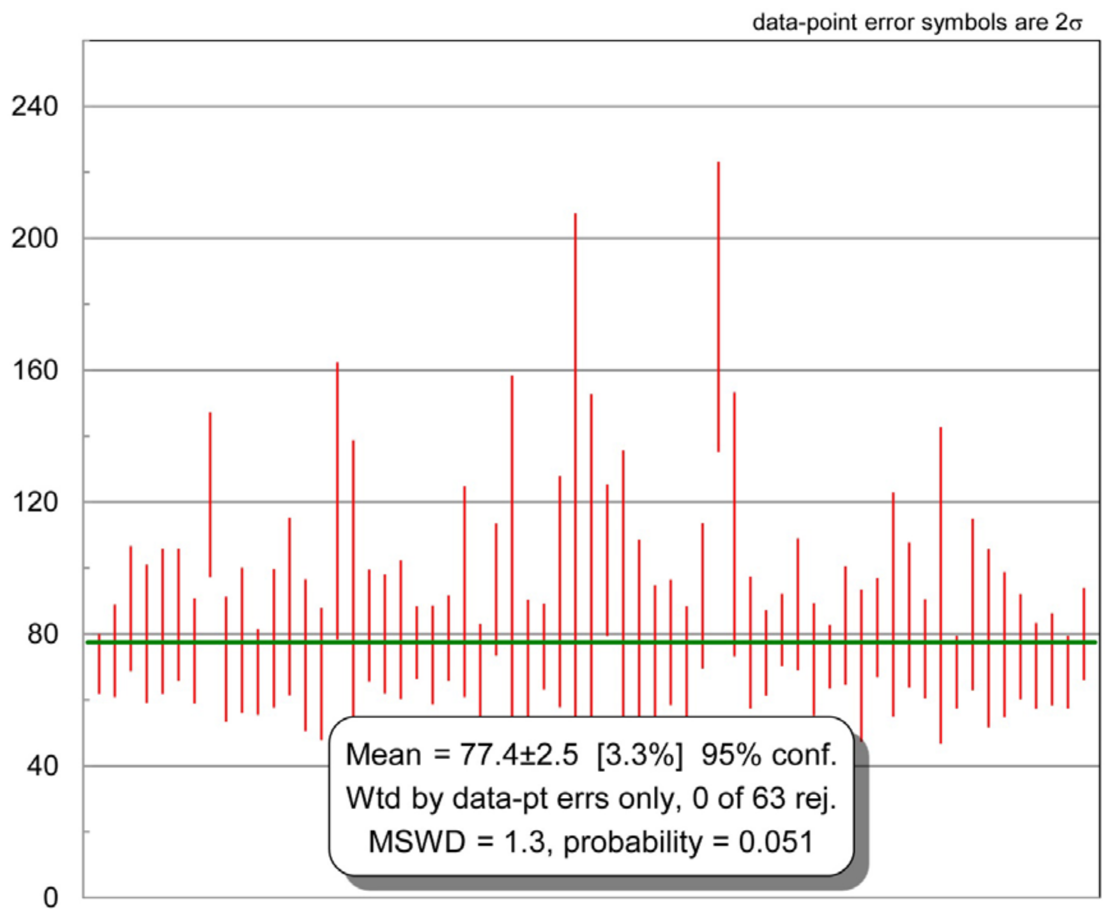

Figure DR5. Measured Δ_{47} vs $\delta^{13}C_{VPDB}$ for the radiaxial, equant and vug filling cements analyzed in this study. There is no clear relationship between measured carbonate clumped isotope temperature and $\delta^{13}C_{VPDB}$ for the samples analyzed here. Error bars represent the uncertainty on the measured Δ_{47} temperatures. The uncertainty associated with measured $\delta^{13}C$ is smaller than the symbols denoting the different fabrics.

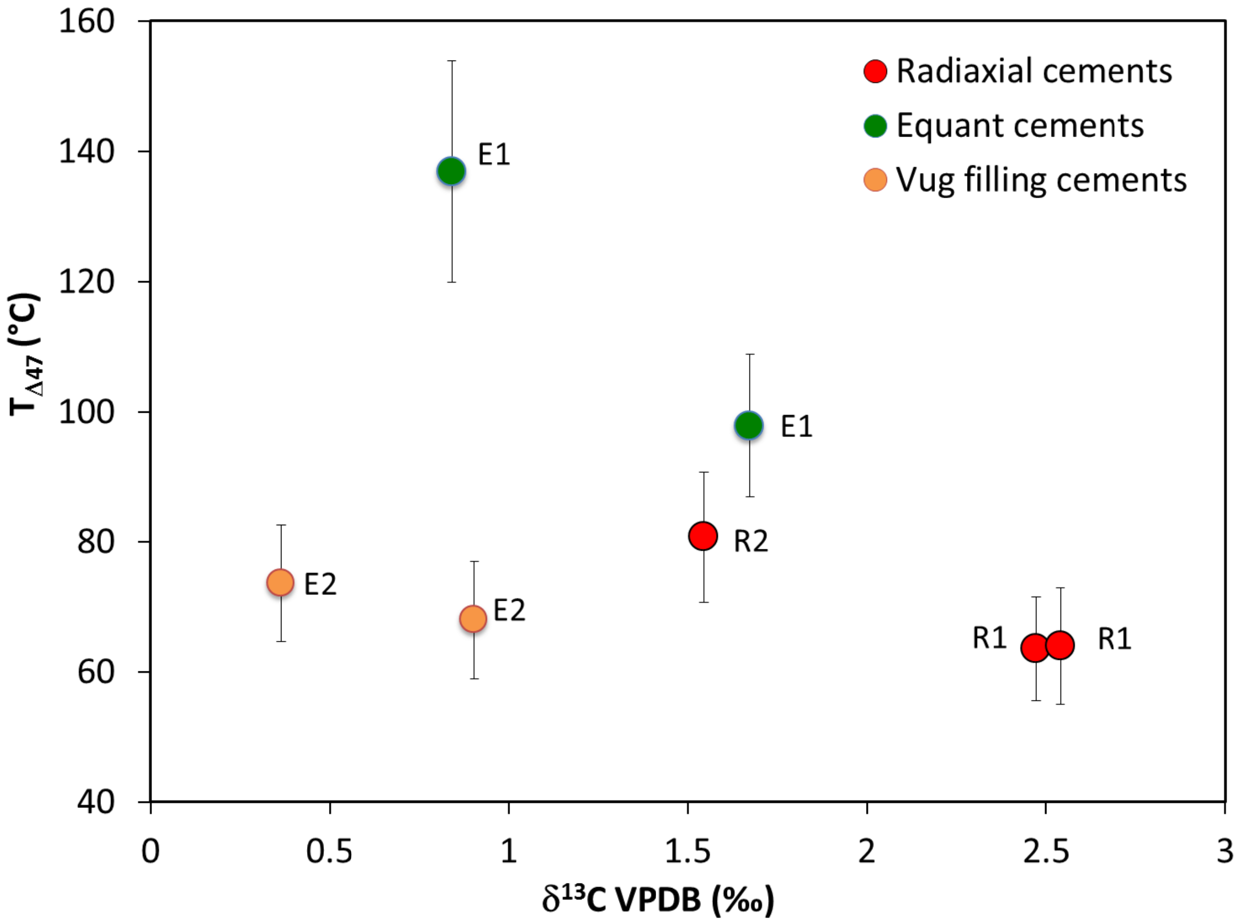

Figure DR6. Measured Δ_{47} vs $\delta^{18}O_{VPDB}$ for the radiaxial, equant and vug filling cements analyzed in this study. There is no clear relationship between measured carbonate clumped isotope temperature and $\delta^{18}O_{VPDB}$ for the samples analyzed here. Error bars represent the uncertainty on the measured Δ_{47} temperatures. The uncertainty associated with measured $\delta^{18}O$ is smaller than the symbols denoting the different fabrics.

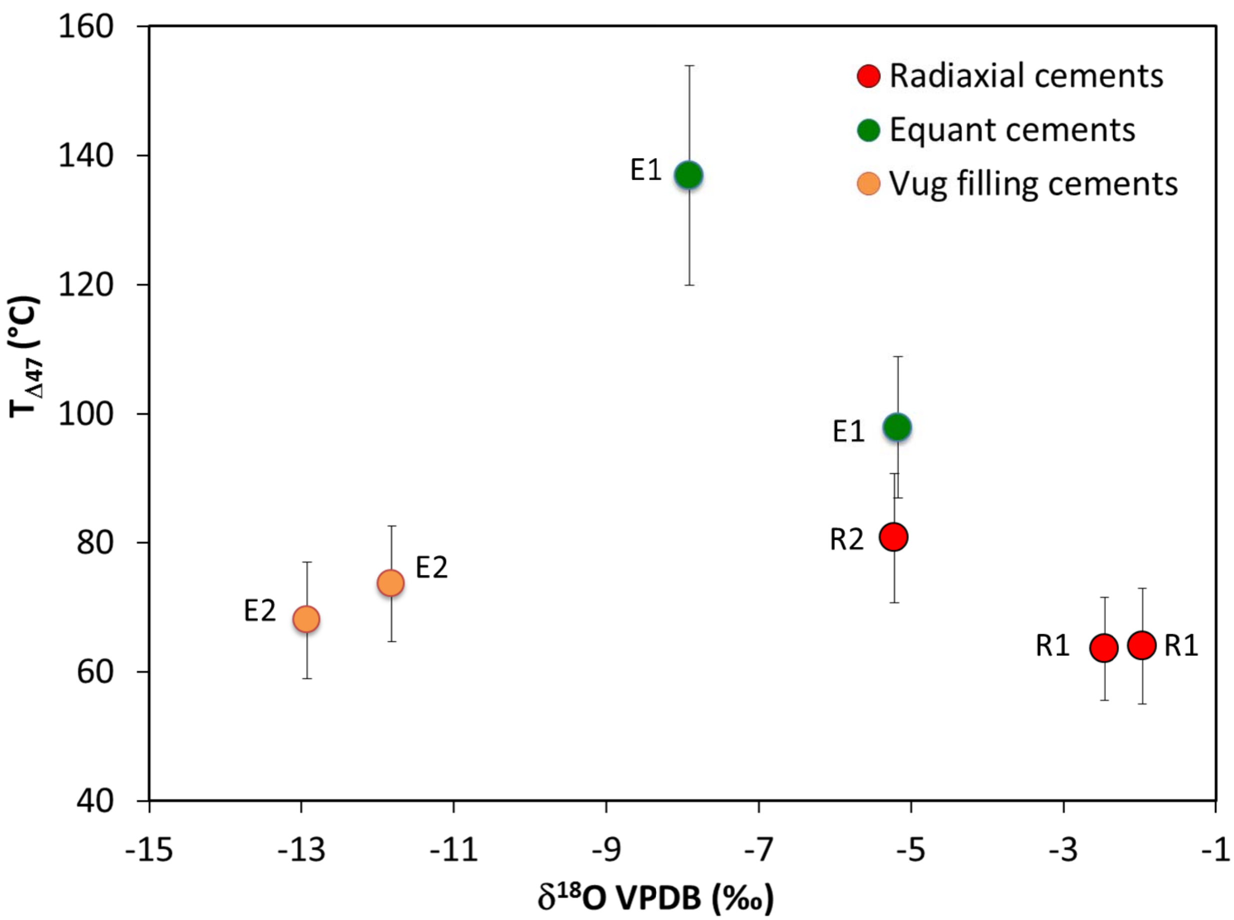

Figure DR7. Evolution in Δ_{47} clumped isotope temperatures of a hypothetical calcite cement that formed at 25°C (analogous to the R1 calcite analyzed in this study) for the high heat flow time-temperature history of the El Abra Formation. In this thermal history, the maximum burial temperature is 193°C at 33 Ma. We apply the paired "reaction-diffusion" model of Stolper and Eiler (2015) as described in the main text to estimate the reordered Δ_{47} clumped isotope temperature at time = 0 for this thermal history. This thermal history would give rise to a Δ_{47} clumped isotope temperature of 139°C, higher than all of the samples measured in this study. This suggests that the base case thermal history applied in the modeling of original precipitation temperatures described in the main text is appropriate, and that the uncertainty on the thermal history is likely small.

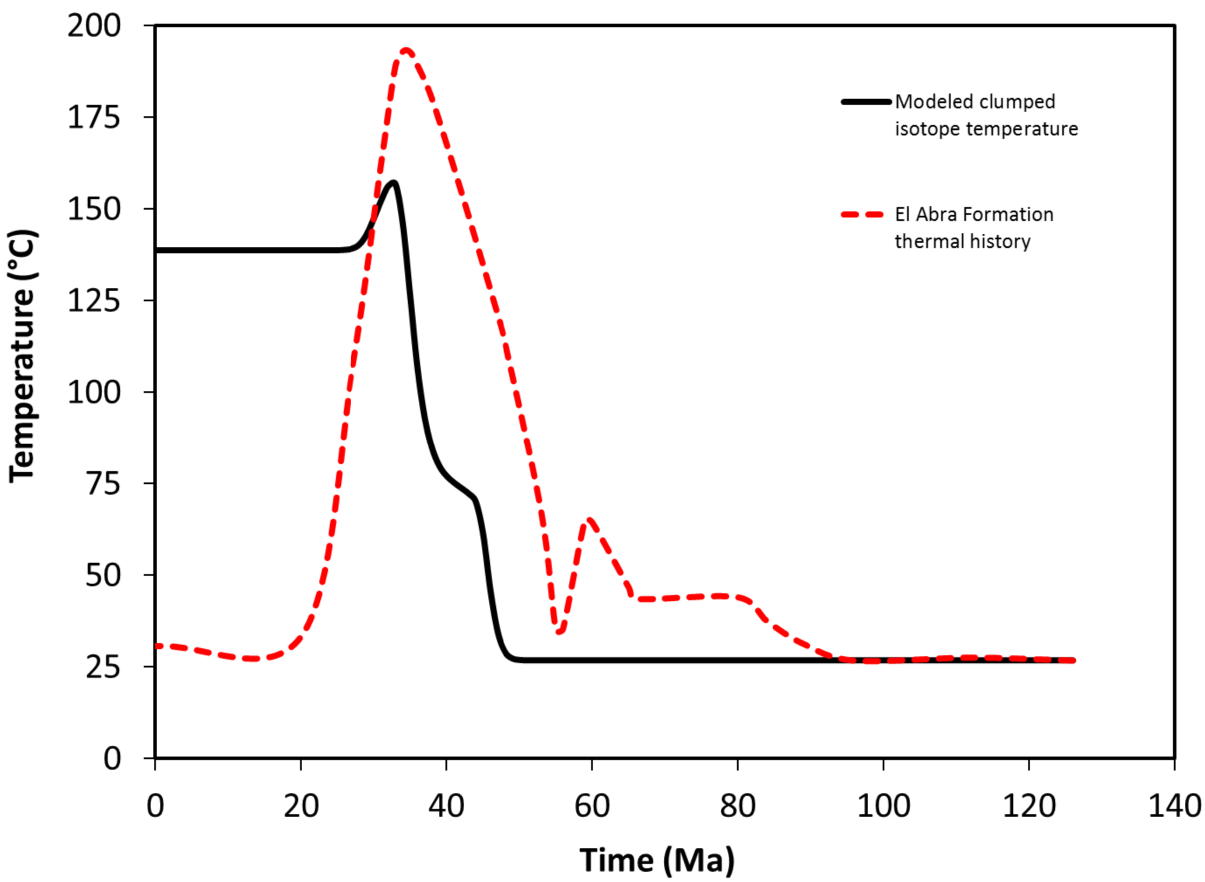

TABLE DR1. U-PB LASER ABLATION ICPMS DATA

SPOT	$^{238}U/^{206}Pb$	% err	$^{207}Pb/^{206}Pb$	% err	$^{208}Pb/^{206}Pb$	% err	U (ppm)	% err	Pb (ppm)	% err
bigvien_1	27.78	131	0.59	100	2.00	260	0.0	24	0.0	94
bigvien_2			0.02	3200	0.38	150	0.0	23	0.0	87
bigvien_3	14.49	91	0.25	148	-7.69	-677	0.0	20	0.0	106
bigvien_4			0		4.76	390	0.0	22	0.0	76
bigvien_5	71.43	271	0.65	66	-14.29	-614	0.0	33	0.0	380
bigvien_6	64.10	19	0.59	58	-10.00	-920	0.2	15	0.0	118
bigvien_7	78.74	26	0.16	156	-1.25	-123	0.2	16	0.0	147
bigvien_8	58.82	26	0.18	83	10.00	1200	0.2	10	0.0	68
bigvien_9	66.23	31	0.28	332	-0.83	-208	0.2	20	0.0	83
bigvien_10	71.94	24	0.4	80	-0.33	-113	0.2	18	0.0	108
host_1	25.97	8	0.556	7	1.28	4	1.7	10	0.5	15
host_2	28.99	3	0.541	4	1.25	4	1.6	10	0.4	12
host_3	27.32	6	0.485	7	1.27	5	0.9	17	0.2	20
host_4	27.17	4	0.486	7	1.22	5	0.8	13	0.2	12
host_5	27.47	5	0.551	6	1.25	6	0.7	21	0.2	20
radiax_1	9.52	12	0.738	5	1.80	6	0.4	6	0.4	20
radiax_2	6.94	9	0.76	6	1.84	4	0.3	7	0.4	10
radiax_3	12.08	7	0.713	4	1.70	4	0.6	8	0.5	12
radiax_4	20.24	15	0.652	7	1.50	6	1.2	12	0.4	7
radiax_5	8.70	10	0.757	3	1.82	3	1.0	10	1.2	5
radiax_6	13.51	24	0.624	5	1.48	5	1.5	14	1.0	16
radiax_7	1.72	19	0.714	3	1.81	3	1.3	23	6.9	22
radiax_8	6.02	10	0.748	4	1.85	4	0.5	15	1.0	21
radiax_9	7.74	6	0.743	4	1.88	3	0.3	5	0.5	9
radiax_10	8.24	7	0.754	6	1.87	4	0.3	19	0.4	12
radiax_11	25.84	6	0.557	5	1.36	4	1.7	13	0.6	12
radiax_12	14.49	20	0.625	10	1.40	6	1.3	16	1.2	31
radiax_13	3.32	15	0.765	4	1.91	4	0.3	25	0.8	11
radiax_14	7.78	7	0.762	8	1.82	6	0.2	13	0.3	16
radiax_15	6.62	11	0.777	7	1.78	7	0.2	8	0.3	12
Output_1_0	12.82	23	0.64	19	1.35	18	0.9	10	0.9	36
Output_1_1	37.31	11	0.55	56	0.96	14	0.8	10	0.2	15
Output_1_2	14.49	90	0.61	20	2.27	64	1.1	15	1.5	17
Output_1_3	14.99	13	0.714	11	1.10	62	1.4	10	1.2	10
Output_1_4	59.88	28	0.22	64	0.22	191	1.4	14	0.1	52
Output_1_5	17.86	152	0.146	40	0.04	96	1.3	6	0.1	46
Output_1_6	72.46	11	0.117	53	0.02	80	2.2	16	0.1	38
Output_1_7	56.18	17	0.219	39	0.18	73	1.7	6	0.1	54
Output_1_8	65.79	14	0.142	53	0.03	79	1.4	13	0.1	63
Output_1_9	56.50	19	0.27	67	0.56	111	1.4	8	0.2	63
Output_1_10	83.33	142	0.25	84	0.07	100	0.8	10	0.1	59
Output_1_11	65.79	14	0.23	61	0.19	100	1.0	11	0.0	44
Output_1_12	33.33	43	0.6	50	0.88	18	1.1	16	0.2	16
Output_1_13	59.88	23	0.31	106	0.07	87	0.7	18	0.1	71
Output_1_14	64.94	14	0.26	77	0.04	76	1.3	10	0.1	69
Output_1_15	72.99	11	0.121	49	0.02	66	1.7	9	0.1	73
Output_1_16	59.52	27	0.25	88	0.04	81	1.1	13	0.1	114
Output_1_17	59.52	20	0.37	73	0.29	103	0.9	18	0.1	58
Output_1_18	70.92	16	0.12	125	0.02	60	1.4	10	0.1	67
Output_1_19	74.07	11	0.12	92	0.03	84	1.6	17	0.0	59
Output_1_20	45.25	19	0.2	170	0.06	83	0.7	14	0.1	66
Output_1_21	62.50	31	0.143	43	0.03	103	2.5	4	0.2	131
Output_1_22	26.32	113	0.201	44	0.13	111	1.3	13	0.1	53
Output_1_23	64.94	14	0.25	64	0.04	83	1.1	15	0.0	68
Output_1_24	61.73	24	0.23	65	0.04	73	0.8	16	0.0	56
Output_1_25	70.42	10	0.035	211	0.06	119	1.8	14	0.0	59
Output_1_26	64.10	13	0.088	84	0.33	117	1.2	13	0.1	76
Output_1_27	62.89	13	0.106	90	0.14	115	1.0	12	0.0	45
Output_1_28	55.25	14	0.18	72	0.02	59	0.8	10	0.0	45
Output_1_29	69.44	15	0.34	94	0.04	85	1.7	15	0.0	74
Output_1_30	54.95	15	0.15	247	0.13	106	0.7	12	0.0	68
Output_1_31	59.88	19	0.182	48	0.13	99	1.2	12	0.0	56
Output_1_32	65.36	19	0.07	214	0.07	107	1.5	14	0.0	51
Output_1_33	72.46	10	0.17	59	0.03	94	2.7	17	0.1	56
Output_1_34	53.76	24	0.34	68	0.06	81	0.9	16	0.1	63
Output_1_35	44.05	27	0.27	137	0.20	104	0.9	20	0.1	49
Output_1_36	79.37	13	0.15	80	0.04	77	1.7	16	0.0	61
Output_1_37	46.51	11	0.53	26	0.26	126	1.0	10	0.1	24
Output_1_38	66.67	16	0.31	68	0.15	100	1.0	12	0.0	43
Output_1_39	64.10	17	0.15	160	0.12	95	0.9	18	0.1	40
Output_1_40	68.49	29	0.07	514	0.25	218	0.8	28	0.0	54
Output_1_41	70.42	12	0.17	59	0.06	106	1.3	10	0.0	45
Output_1_42	71.94	15	0.077	123	0.04	73	1.0	9	0.0	46
Output_1_43	54.35	12	0.168	57	0.17	147	1.9	14	0.2	59
Output_1_44	30.30	18	0.49	24	0.88	20	1.1	19	0.2	19
Output_1_45	40.98	28	0.16	94	1.43	229	0.7	7	0.1	60
Output_1_46	68.03	18	0.13	115	0.26	153	1.1	15	0.0	46
Output_1_47	67.11	11	0.106	89	0.13	113	1.2	12	0.0	43

Output_1_48	*65.79*	*9*	*0.159*	*41*	*0.10*	*130*	*1.6*	*10*	*0.0*	*38*
Output_1_49	60.24	15	0.17	65	0.18	89	1.1	15	0.1	51
Output_1_50	*71.94*	*13*	*0.056*	*159*	*0.53*	*100*	*1.4*	*7*	*0.0*	*47*
Output_1_51	*69.44*	*10*	*0.134*	*52*	*0.14*	*103*	*2.3*	*13*	*0.0*	*28*
Output_1_52	*37.04*	*89*	*0.142*	*39*	*0.22*	*98*	*2.1*	*14*	*0.1*	*38*
Output_1_53	90.91	155	0.43	98	0.06	83	0.9	15	0.0	46
Output_1_54	*62.89*	*12*	*0.24*	*42*	*0.04*	*96*	*1.4*	*7*	*0.0*	*50*
Output_1_55	63.69	20	0.159	60	0.02	68	1.4	7	0.0	59
Output_1_56	57.14	21	0.164	40	0.03	88	1.8	7	0.1	72
Output_1_57	*63.69*	*13*	*0.075*	*100*	*0.05*	*80*	*1.3*	*12*	*0.0*	*48*
Output_1_58	68.03	12	0.154	52	0.01	60	1.5	7	0.0	65
Output_1_59	*85.47*	*28*	*0.09*	*80*	*0.04*	*104*	*2.0*	*7*	*0.0*	*71*
Output_1_60	64.10	14	0.145	43	0.02	84	2.0	10	0.0	71
Output_1_61	67.11	17	0.199	48	0.03	85	1.5	3	0.1	64
Output_1_62	*57.47*	*24*	*0.09*	*233*	*0.03*	*77*	*1.0*	*12*	*0.0*	*60*
Output_1_63	74.07	13	0.163	43	0.02	73	1.7	8	0.0	42
Output_1_64	*56.82*	*41*	*0.1*	*160*	*0.04*	*85*	*1.2*	*12*	*0.0*	*73*
Output_1_65	62.89	19	0.2	55	0.04	78	1.1	5	0.0	39
Output_1_66	*67.11*	*13*	*0.034*	*162*	*0.13*	*125*	*1.4*	*13*	*0.0*	*75*
Output_1_67	*63.69*	*11*	*0.105*	*70*	*0.19*	*149*	*1.5*	*16*	*0.0*	*43*

Data reduction from Iolite (Paton *et al*., 2011).

TABLE DR2. INDIVIDUAL MEASUREMENTS FOR HEATED GASES, SAMPLES AND STANDARDS ANALYZED AS PART OF THIS STUDY

	Sample ID	$\delta^{13}C$ (‰, VPDB)	$\delta^{13}C$ stdev	$\delta^{18}O$ gas (‰, SMOW)	$\delta^{18}O$ mineral (‰, VPDB)	$\delta^{18}O$ stdev	δ47 (v. Oz)	δ47 stdev	Δ47 (v. Oz)	Δ47 stdev	Δ47 sterror	HG corrected Δ47	stretching corrected Δ47	Δ47 acid digestion Corrected (‰)	accepted value	residual
Session 1																
Heated gases	eBOC	-11.092	0.005	48.896	9.211	0.011	15.675	0.032	-0.622	0.021	0.007					
	BOC	-10.880	0.007	30.132	-8.843	0.011	-2.816	0.023	-0.798	0.018	0.006					
	eBOC	-10.491	0.009	51.447	11.665	0.011	18.844	0.028	-0.567	0.033	0.012					
	BOC	-10.777	0.005	29.438	-9.511	0.009	-3.448	0.025	-0.848	0.029	0.010					
	eBOC	-10.902	0.008	49.964	10.238	0.014	16.944	0.030	-0.595	0.035	0.012					
	BOC	-10.835	0.011	28.985	-9.947	0.021	-3.957	0.023	-0.854	0.027	0.010					
	eBOC	-10.859	0.008	57.925	17.898	0.019	24.955	0.025	-0.490	0.028	0.010					
	BOC	-10.791	0.003	29.462	-9.488	0.013	-3.406	0.016	-0.816	0.009	0.003					
Session 2																
Heated gases	BOC	-10.707	0.005	28.571	-10.345	0.006	-4.278	0.060	-0.890	0.053	0.019					
	eBOC	-10.915	0.010	56.661	16.681	0.028	23.614	0.076	-0.532	0.053	0.019					
	BOC	-10.778	0.005	29.488	-9.464	0.012	-3.403	0.047	-0.852	0.044	0.016					
	eBOC	-10.853	0.007	57.404	17.396	0.013	24.429	0.040	-0.507	0.026	0.009					
	eBOC	-10.730	0.004	56.253	16.289	0.011	23.422	0.027	-0.500	0.031	0.011					
	BOC	-10.825	0.006	29.058	-9.877	0.026	-3.903	0.034	-0.882	0.019	0.007					
	eBOC	-10.551	0.002	56.585	16.609	0.010	23.921	0.041	-0.508	0.032	0.011					
Session 1 standards																
	CIT Carrara	2.162	0.007	37.271	-1.974	0.012	17.442	0.043	-0.341	0.048	0.017	0.246	0.263	0.344	0.352	-0.008
	TV03	3.408	0.005	30.416	-8.571	0.016	12.002	0.046	-0.140	0.043	0.015	0.510	0.545	0.626	0.654	-0.028
	CIT Carrarra	2.161	0.007	37.308	-1.939	0.013	17.481	0.023	-0.338	0.027	0.010	0.249	0.266	0.347	0.352	-0.005
	TV03	3.442	0.006	30.409	-8.577	0.016	12.054	0.022	-0.115	0.024	0.009	0.534	0.571	0.652	0.654	-0.002
	CIT Carrarra	2.161	0.009	37.293	-1.954	0.016	17.479	0.037	-0.325	0.045	0.016	0.261	0.279	0.360	0.352	0.008
	TV03	3.444	0.006	30.487	-8.503	0.014	12.120	0.053	-0.128	0.042	0.015	0.520	0.556	0.637	0.654	-0.017
	CIT Carrara	2.148	0.006	37.320	-1.928	0.010	17.503	0.034	-0.315	0.033	0.012	0.271	0.290	0.371	0.352	0.019
	TV03	3.471	0.013	30.469	-8.519	0.022	12.151	0.052	-0.107	0.041	0.015	0.541	0.579	0.659	0.654	0.005
	CIT Carrara	2.159	0.011	37.277	-1.969	0.020	17.467	0.039	-0.319	0.049	0.017	0.267	0.286	0.366	0.352	0.014
	TV03	3.436	0.007	30.444	-8.543	0.011	12.058	0.029	-0.141	0.031	0.011	0.509	0.544	0.624	0.654	-0.030
	CIT Carrara	2.142	0.005	37.289	-1.957	0.012	17.443	0.025	-0.338	0.028	0.010	0.249	0.266	0.346	0.352	-0.006
Session 2 standards																
	TV03	3.422	0.005	30.371	-8.614	0.009	11.978	0.036	-0.136	0.035	0.012	0.577	0.576	0.656	0.650	0.006
	CIT Carrera	2.158	0.003	37.236	-2.008	0.007	17.405	0.038	-0.338	0.031	0.011	0.257	0.265	0.345	0.352	-0.007
	TV03	3.425	0.005	30.368	-8.617	0.004	11.999	0.043	-0.113	0.044	0.015	0.552	0.569	0.649	0.650	-0.001
	CIT Carrera	2.163	0.005	37.189	-2.053	0.007	17.349	0.043	-0.356	0.042	0.015	0.240	0.247	0.327	0.352	-0.025
	TV03	3.395	0.004	30.360	-8.624	0.006	11.963	0.046	-0.112	0.039	0.014	0.554	0.571	0.651	0.650	0.001
	CIT Carrera	2.157	0.005	37.208	-2.035	0.010	17.368	0.045	-0.346	0.039	0.014	0.249	0.257	0.337	0.352	-0.015
	TV03	3.411	0.004	30.377	-8.608	0.009	11.981	0.045	-0.125	0.036	0.013	0.540	0.557	0.637	0.650	-0.013
	CIT Carrera	1.909	0.002	37.873	-1.395	0.011	17.783	0.041	-0.361	0.022	0.008	0.229	0.237	0.317	0.352	-0.035
	TV03	3.409	0.005	30.409	-8.577	0.004	12.028	0.049	-0.114	0.045	0.016	0.551	0.568	0.648	0.650	-0.002
	CIT Carrera	2.151	0.004	37.231	-2.013	0.004	17.392	0.044	-0.343	0.041	0.015	0.253	0.260	0.340	0.352	-0.012
Session 1 samples																
	CAN-9A	2.088	0.007	34.001	-5.121	0.014	14.208	0.021	-0.235	0.029	0.010	0.389	0.413	0.494		
	CAN-9A	2.070	0.006	34.088	-5.037	0.013	14.267	0.034	-0.245	0.036	0.013	0.378	0.401	0.482		
	CAN-3A	2.091	0.006	34.582	-4.562	0.012	14.802	0.013	-0.224	0.020	0.007	0.392	0.416	0.497		
	CAN-11A	0.916	0.008	25.904	-12.912	0.016	4.894	0.017	-0.322	0.030	0.011	0.415	0.440	0.521		
	CAN-11A	0.892	0.008	25.871	-12.944	0.016	4.832	0.031	-0.328	0.040	0.014	0.409	0.434	0.515		
	CMEX-1	1.693	0.011	35.618	-3.565	0.018	15.433	0.031	-0.240	0.050	0.018	0.369	0.391	0.472		
	CMEX-1	1.671	0.004	35.675	-3.510	0.008	15.460	0.027	-0.250	0.027	0.010	0.359	0.381	0.462		
	CMEX-3	1.693	0.006	33.930	-5.189	0.012	13.714	0.013	-0.273	0.027	0.010	0.357	0.379	0.460		
	CMEX-3	1.653	0.011	33.971	-5.150	0.020	13.721	0.041	-0.268	0.040	0.014	0.361	0.384	0.465		
	TAN104	0.847	0.006	31.252	-7.766	0.012	10.125	0.033	-0.363	0.037	0.013	0.310	0.329	0.410		
	TAN 104	0.836	0.005	30.961	-8.046	0.007	9.822	0.030	-0.364	0.033	0.012	0.313	0.332	0.413		
Session 2 samples																
	CMEX3R	2.472	0.004	36.767	-2.460	0.008	17.422	0.035	-0.162	0.030	0.011	0.433	0.447	0.528		
	CMEX6R	2.540	0.005	37.285	-1.962	0.009	18.014	0.059	-0.155	0.057	0.020	0.432	0.446	0.527		
	CMEX6R2	1.544	0.004	33.907	-5.211	0.007	13.576	0.048	-0.242	0.041	0.014	0.402	0.415	0.496		
	CMEX6R2	1.547	0.003	33.898	-5.220	0.010	13.562	0.024	-0.251	0.019	0.007	0.394	0.406	0.487		
	TAN101	0.366	0.005	27.048	-11.811	0.007	5.489	0.040	-0.337	0.041	0.015	0.412	0.425	0.506		