SUPPLEMENTAL INFORMATION

^{238}U-^{234}U-^{230}Th Mass Spectrometry Dating

For TIMS, isotopic ratios (^{236}U, ^{235}U, ^{234}U, ^{233}U, ^{232}Th, ^{230}Th, ^{229}Th) were measured using a Micromass Sector 54 thermal ionization mass spectrometer in ion counting mode. For MC-ICP-MS, isotopic ratios were measured using a Thermo Neptune multi-collector inductively coupled plasma mass spectrometer. The U and Th fractions were dissolved and combined in a 3%–5% HNO_3 4 ml solution which was then aspirated into the Neptune using a Cetac Aridus II low flow (50–100 μl/min) desolvating nebulizer system. Static measurements were made with the following Faraday cup (resistor) counting arrangement: ^{229}Th ($10^{12}\Omega$), ^{232}Th ($10^{11}\Omega$), ^{233}U ($10^{12}\Omega$), ^{235}U ($10^{11}\Omega$), ^{236}U ($10^{12}\Omega$), ^{238}U ($10^{10}\Omega$), and with ^{230}Th measured in a channeltron ion counter and ^{234}U in an SEM**.** SEM and channeltron yields were monitored by spiked standard bracketing.

The age model used to assign ages to each stable isotope analysis was derived using simple linear interpolation between dated intervals. The only complication to this technique arose in the GC2 where, because of its fast growth rate and old age (which imparts an error of several hundred years even when isotopic analyses achieved high precision), the ages cluster in a narrow range with some age inversions. Thus for the top half of this stalagmite, the age model utilized only two MC-ICP-MS radiometric dates (because of their small uncertainties relative to TIMS) which were spaced by the most distance. U-Th isotopic analyses integrate 150 yr of growth, respectively.

Stable Isotope Data and Age Model

The following table includes the U-Th dates and the linearly interpolated (color coded) growth rates used to assign an age to each stable isotope analysis. Each analysis integrates approximately 15 years of growth.

Stalagmite	Distance from Bottom (mm)	Age	Growth Rate (yr/mm)
GC2	62	100,510	23.2
GC2	100	99,630	22.0
GC2	144	98,660	
GC2	175	96,200	19.1
GC2	198	95,760	
GC2	329	91,340	5.2
GC2	438	90,770	
GC3	5	86,140	20.8
GC3	102	84,120	
GC4	22	5,990	11.8
GC4	145	4,540	

Stalagmite	mm	age	$\delta^{13}C$	$\delta^{18}O$
GC2	444.0	90,169	-4.10	-15.11
GC2	440.0	90,190	-4.41	-15.91
GC2	432.0	90,231	-5.31	-15.77
GC2	425.0	90,268	-5.12	-15.47
GC2	417.0	90,310	-3.45	-15.24
GC2	413.0	90,331	-2.50	-15.38
GC2	407.0	90,362	-3.65	-15.27
GC2	401.0	90,393	-5.52	-15.37
GC2	423.0	90,278	-4.33	-15.29
GC2	416.0	90,315	-3.38	-15.22
GC2	411.0	90,341	-2.31	-15.24
GC2	406.0	90,367	-3.68	-15.43
GC2	399.0	90,404	-5.99	-16.27
GC2	390.0	90,451	-6.04	-15.78
GC2	383.0	90,488	-4.68	-15.37
GC2	376.0	90,524	-6.20	-15.75
GC2	372.0	90,545	-5.17	-15.76
GC2	364.0	90,587	-5.74	-15.39
GC2	359.0	90,613	-4.43	-15.67

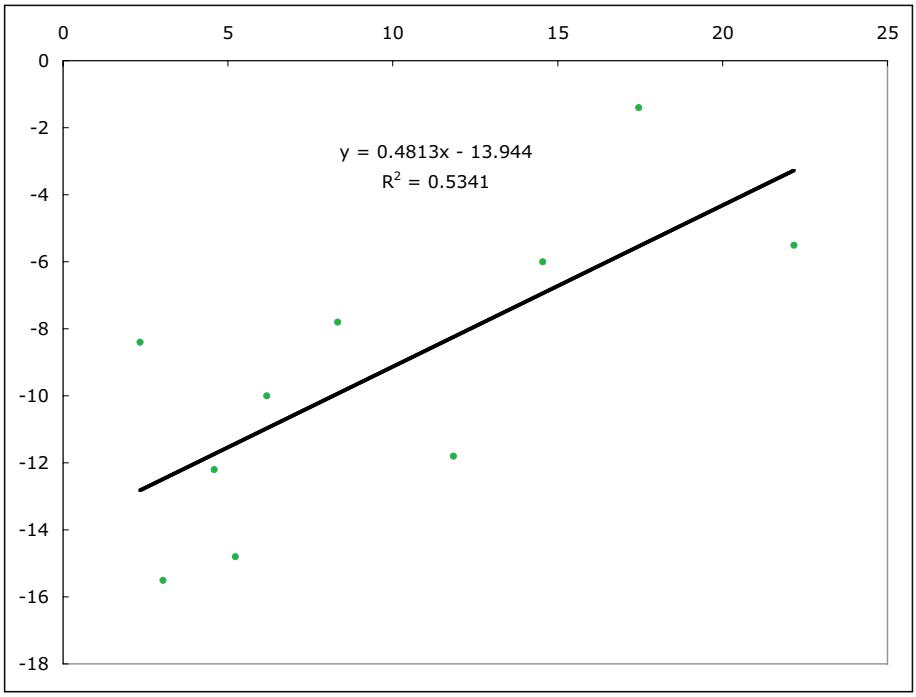
GC2	354.0	90,639	-4.19	-15.43
GC2	349.0	90,665	-3.99	-14.79
GC2	342.0	90,702	-5.71	-16.22
GC2	336.0	90,733	-3.66	-15.29
GC2	330.0	90,765	-3.33	-15.32
GC2	320.0	90,817	-3.77	-15.17
GC2	314.0	90,848	-5.92	-15.44
GC2	310.0	90,869	-6.41	-15.96
GC2	306.0	90,890	-5.95	-15.92
GC2	300.0	90,922	-5.51	-15.96
GC2	292.0	90,963	-5.72	-15.61
GC2	287.0	90,990	-5.65	-15.99
GC2	282.0	91,016	-5.84	-15.94
GC2	273.0	91,063	-4.67	-15.82
GC2	267.0	91,094	-4.60	-16.04
GC2	260.0	91,131	-5.09	-15.81
GC2	254.0	91,162	-5.23	-15.25
GC2	248.0	91,194	-4.58	-15.63
GC2	243.0	91,220	-4.99	-15.40
GC2	237.0	91,251	-5.61	-16.16
GC2	230.0	91,288	-4.60	-15.87
GC2	220.0	91,340	-5.86	-16.13
GC2	214.0	91,371	-4.20	-15.67
GC2	209.0	91,398	-5.59	-15.44
GC2	204.0	91,424	-4.92	-16.11
GC2	200.0	91,445	-5.36	-15.36
GC2	195.0	95,817	-5.48	-15.47
GC2	192.0	95,875	-3.59	-15.74
GC2	188.0	95,951	-4.96	-15.79
GC2	184.0	96,028	-5.25	-15.84
GC2	178.0	96,143	-5.49	-15.98
GC2	168.0	96,334	-6.07	-16.05
GC2	163.5	96,420	-5.08	-15.97
GC2	153.0	96,621	-5.84	-15.90
GC2	147.0	96,736	-5.11	-15.88
GC2	143.0	98,682	-5.1	-15.56
GC2	138.5	98,781	-5.25	-15.44
GC2	135.0	98,858	-5.77	-15.88
GC2	131.0	98,947	-4.91	-15.61
GC2	127.0	99,035	-5.26	-15.56
GC2	123.0	99,123	-5.75	-15.78
GC2	119.0	99,211	-4.85	-15.65
GC2	114.0	99,321	-5.27	-15.59

GC2	110.0	99,410	-4.31	-15.39
GC2	105.0	99,520	-4.61	-15.31
GC2	100.0	99,630	-4.13	-15.15
GC2	95.0	99,746	-4.92	-15.83
GC2	91.0	99,838	-4.32	-15.43
GC2	87.0	99,931	-4.16	-15.36
GC2	83.0	100,024	-4.45	-15.14
GC2	79.0	100,116	-4.67	-15.14
GC2	75.0	100,209	-4.14	-14.77
GC2	70.0	100,325	-4.99	-15.53
GC2	65.0	100,441	-4.48	-15.13
GC2	60.0	100,556	-4.42	-15.25
GC2	55.5	100,661	-4.23	-15.25
GC2	51.0	100,765	-4.36	-15.04
GC2	47.0	100,857	-5.04	-15.37
GC2	42.5	100,962	-4.57	-15.31
GC2	38.5	101,054	-5.01	-15.55
GC2	34.0	101,158	-4.89	-15.39
GC2	30.0	101,251	-5.21	-15.4
GC2	23.0	101,413	-5.25	-15.78
GC2	20.0	101,483	-5.58	-15.87
GC2	17.0	101,552	-5.28	-15.28
GC2	13.0	101,645	-6.17	-15.79
GC2	10.0	101,714	-5.53	-15.89
GC2	7.0	101,784	-5.44	-15.59
GC2	6.5	101,795	-6.15	-16.16
GC2	5.0	101,830	-5.41	-16.70
GC2	4.0	101,853	-5.65	-16.25
GC2	2.0	101,899	-4.53	-15.41
GC3	122.0	83,704	-5.20	-13.28
GC3	121.0	83,724	-5.20	-13.72
GC3	119.0	83,766	-4.31	-13.24
GC3	117.0	83,808	-2.39	-15.15
GC3	113.0	83,891	-4.05	-15.38
GC3	109.0	83,974	-5.11	-15.77
GC3	104.0	84,078	-5.68	-14.85
GC3	100.0	84,162	-4.26	-15.74
GC3	95.0	84,266	-5.44	-15.65
GC3	90.0	84,370	-5.75	-15.49
GC3	87.0	84,432	-5.51	-15.63
GC3	82.0	84,536	-5.66	-15.37
GC3	78.0	84,620	-6.74	-15.58
GC3	72.0	84,745	-6.52	-15.48
GC3	67.0	84,849	-7.68	-16.36
GC3	61.0	84,974	-7.02	-15.49

GC3	57.0	85,057	-6.40	-16.59
GC3	50.0	85,203	-6.76	-15.91
GC3	46.0	85,286	-6.35	-15.52
GC3	41.0	85,390	-6.78	-16.53
GC3	35.0	85,515	-6.58	-15.98
GC3	32.0	85,578	-7.66	-16.54
GC3	28.0	85,661	-6.73	-16.55
GC3	24.0	85,744	-6.14	-15.33
GC3	19.0	85,848	-5.65	-15.13
GC3	11.0	86,015	-5.33	-15.32
GC3	6.0	86,119	-3.25	-15.62
GC3	1.0	86,223	-3.44	-15.71
GC4	148.0	4,505	-4.41	-14.08
GC4	145.0	4,540	-5.08	-14.56
GC4	142.0	4,575	-4.29	-14.07
GC4	138.5	4,617	-5.70	-14.73
GC4	135.0	4,658	-5.64	-14.41
GC4	131.0	4,705	-5.84	-14.89
GC4	123.5	4,793	-4.88	-14.15
GC4	120.0	4,835	-3.56	-13.83
GC4	116.0	4,882	-3.56	-14.11
GC4	112.5	4,923	-4.98	-14.20
GC4	109.0	4,964	-4.13	-13.95
GC4	105.5	5,006	-3.67	-13.89
GC4	102.5	5,041	-4.00	-13.67
GC4	99.0	5,082	-4.60	-13.91
GC4	95.0	5,129	-4.08	-14.18
GC4	92.0	5,165	-3.01	-13.59
GC4	88.0	5,212	-4.17	-13.58
GC4	85.0	5,247	-5.38	-13.62
GC4	81.0	5,294	-4.86	-13.92
GC4	77.5	5,336	-4.30	-14.20
GC4	74.5	5,371	-4.41	-13.50
GC4	70.5	5,418	-5.00	-13.95
GC4	67.0	5,460	-5.30	-13.99
GC4	63.0	5,507	-4.87	-14.13
GC4	59.5	5,548	-6.00	-13.97
GC4	56.0	5,589	-4.05	-14.30
GC4	52.5	5,630	-4.68	-14.38
GC4	48.0	5,683	-4.25	-14.23
GC4	44.0	5,731	-4.85	-13.75
GC4	40.0	5,778	-4.53	-14.23
GC4	37.0	5,813	-4.18	-13.74
GC4	33.0	5,860	-4.11	-13.62
GC4	29.0	5,907	-4.01	-14.22

GC4	25.0	5,955	-4.43	-13.93
GC4	21.5	5,996	-3.43	-13.56
GC4	15.0	6,073	-4.55	-14.23
GC4	10.5	6,126	-4.07	-14.77
GC4	6.5	6,173	-4.68	-14.08
GC4	2.0	6,226	-4.33	-14.22

Ruby Valley Precipitation Stable Isotopic Data

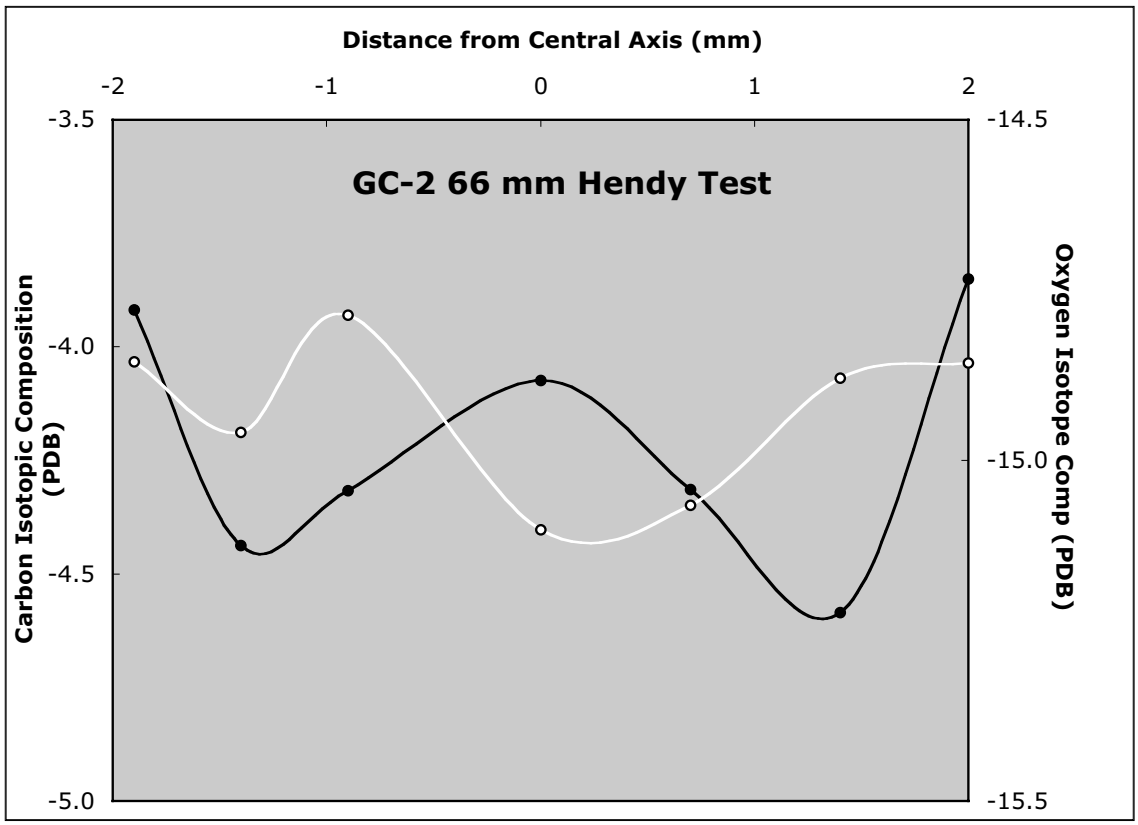


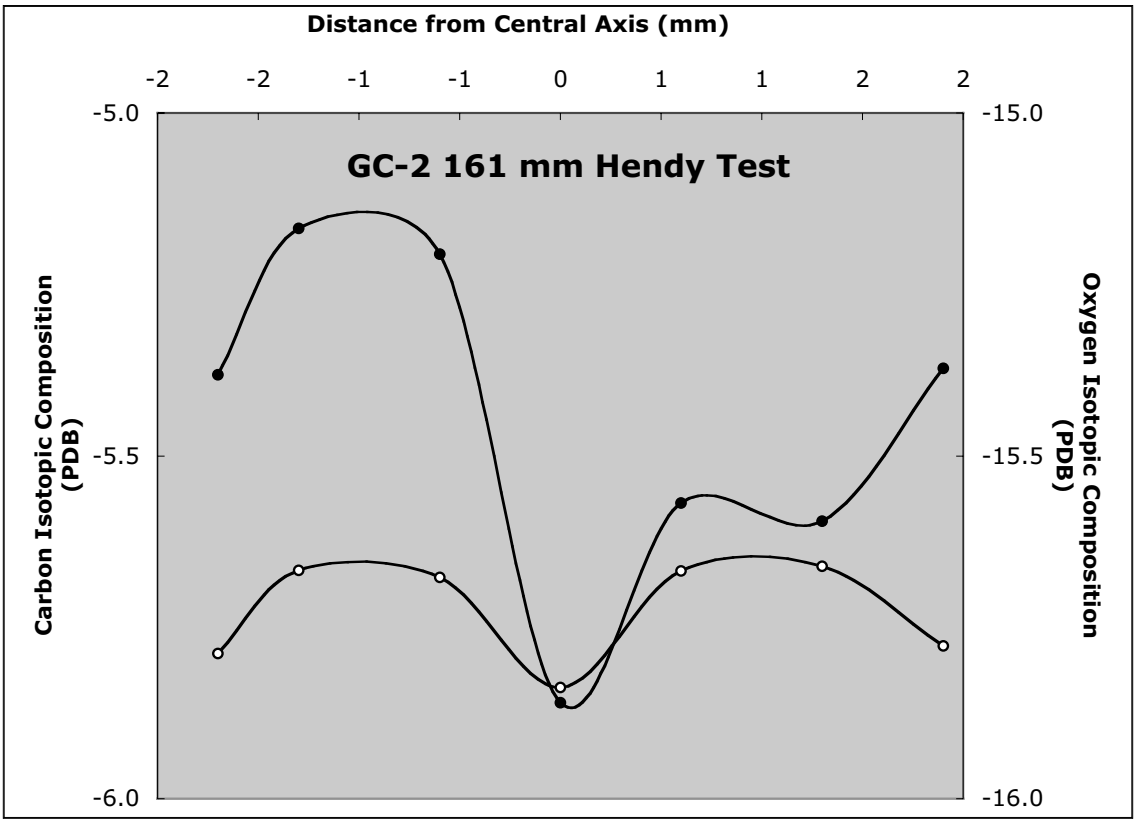
Ruby Valley Precipitation Data
Data courtesy of Dr. Larry Benson, USGS, Boulder, CO

STATION	DATE_PREC	$\delta^{18}O$ (PDB)	AVG_TEMP
RUBY VALLEY	23-Apr-90	11.84	-11.8
RUBY VALLEY	24-Apr-90	5.22	-14.8
RUBY VALLEY	26-Apr-90	4.58	-12.2
RUBY VALLEY	05-May-90	2.33	-8.4
RUBY VALLEY	08-May-90	3.03	-15.5
RUBY VALLEY	11-May-90	6.17	-10.0
RUBY VALLEY	24-Jul-90	14.54	-6.0
RUBY VALLEY	21-Aug-90	22.16	-5.5
RUBY VALLEY	09-Sep-90	17.45	-1.4
RUBY VALLEY	18-Sep-90	8.33	-7.8

Hendy Test Data for GC2

Stalagmite	Distance from Bottom (mm)	Direction from Central Axis	Distance from Center (mm)	$\delta^{13}C$ (PDB)	$\delta^{18}O$ (PDB)
GMC-2	66	left	-1.9	-3.92	-14.86
GMC-2	66	left	-1.4	-4.44	-14.96
GMC-2	66	left	-0.9	-4.32	-14.79
GMC-2	66	center	0.0	-4.07	-15.10
GMC-2	66	right	0.7	-4.31	-15.07
GMC-2	66	right	1.4	-4.59	-14.88
GMC-2	66	right	2.0	-3.85	-14.86
GMC-2	161	left	-1.7	-5.38	-15.79
GMC-2	161	left	-1.3	-5.17	-15.67
GMC-2	161	left	-0.6	-5.21	-15.68
GMC-2	161	center	0.0	-5.86	-15.84
GMC-2	161	right	0.6	-5.57	-15.67
GMC-2	161	right	1.3	-5.60	-15.66
GMC-2	161	right	1.9	-5.37	-15.78




Distance from Central Axis (mm)
-2
-2
-1
-1
0
1
1
2
2
GC-2 161 mm Hendy Test
Carbon Isotopic Composition (PDB)
-5.0
-5.5
-6.0
Oxygen Isotopic Composition (PDB)
-15.0
-15.5
-16.0