

Loughney, K.M., Hren, M.T., Smith, S.Y., and Pappas, J.L., 2019, Vegetation and habitat change in southern California through the Middle Miocene Climatic Optimum: Paleoenvironmental records from the Barstow Formation, Mojave Desert, USA: GSA Bulletin, <https://doi.org/10.1130/B35061.1>.

## Data Repository

Figure DR1. Results of  $\delta^{13}\text{C}_{nC29}$  and  $\delta\text{D}_{nC29}$  (closed circles) and  $\delta^{13}\text{C}_{nC31}$  and  $\delta\text{D}_{nC31}$  (open circles).

Figure DR2. Carbon-chain length abundances for  $n\text{C}_{25}$  through  $n\text{C}_{33}$  of 29  $n$ -alkane samples.

TABLE DR1. Age model of phytolith, biomarker, and soil organic matter (SOM) samples collected from the Barstow Formation. Sediment-accumulation rates (SAR) are from Loughney and Badgley (2017). Asterisks denote dated units that serve as tie points for age estimates. Coordinates are in WGS84.

TABLE DR2. Results of phytolith samples from the Barstow Formation. Counted assemblages noted with asterisks, and total number of morphotypes is given for the assemblage. Terminology follows Stromberg (2003). AQ—aquatic morphotypes; FI—forest indicator; GSSC—grass-silica short cell; CH—closed habitat; POOID-D—Poooid, diagnostic; POOID-ND—Poooid, nondiagnostic; PACMAD—Panicoideae, Arundinoideae, Chloridoideae, Micrairoideae, Aristoideae, Danthonioideae; PANI—Panicoideae; CHLOR—Chloridoideae; p—present; vab—very abundant. After Stromberg (2005).

TABLE DR3. Ecological tolerances and affinities of diatom taxa identified in phytolith samples from the Barstow Formation. Compiled from Lohman (1957), Lowe (1974), Gasse (1987), Round et al. (1990), Spaulding et al. (2010), Lange-Bertalot et al. (2011), Beals and Potapova (2013), and Owens et al. (2014).

TABLE DR4. Phytolith and isotopic results of six samples collected along a 106-m lateral transect in the Upper Member of the Barstow Formation. Percentage of forest indicator (FI), grass silica short cell (GSSC), and  $\text{C}_4$  phytolith morphotypes, average chain length (ACL),  $\delta^{13}\text{C}_{nC27-31}$ ,  $\delta\text{D}_{nC27-31}$ , and  $\delta^{13}\text{C}_{\text{SOM}}$  are given for each sample.

TABLE DR5. Carbon isotope results from soil organic matter, weight-percent carbon, estimated age of sample, and reconstructed atmospheric  $\delta^{13}\text{C}$  from Tipple et al. (2010). Reprocessed samples are indicated by number of runs, samples not included in results are in gray.

## SUPPLEMENTAL MATERIAL

### Age Model for Samples

Previous chronostratigraphic work in the Mud Hills and Calico Mountains has resulted in a robust age framework for the Barstow Formation (Woodburne et al., 1990; MacFadden et al., 1990; Singleton and Gans, 2008; Miller et al., 2013). We established stratigraphic control of sediment samples across Barstow outcrops through correlation of measured sections in the field and stratigraphic sections from Lindsay (1972), Woodburne et al. (1990), Lindsay (1995), Abersek and Lofgren (2017), and Loughney and Badgley (2017). Using uncompacted sediment-accumulation rates for each facies association from Loughney and Badgley (2017) and published ages of dated tuffs from MacFadden et al. (1990), Singleton and Gans (2008), and Miller et al. (2013) as tie points, we constructed an absolute age model for sediment samples. The estimated ages of samples are listed in Table S1. Because most samples in the Mud Hills were collected at or near fossil localities, we give approximate sampling location data.

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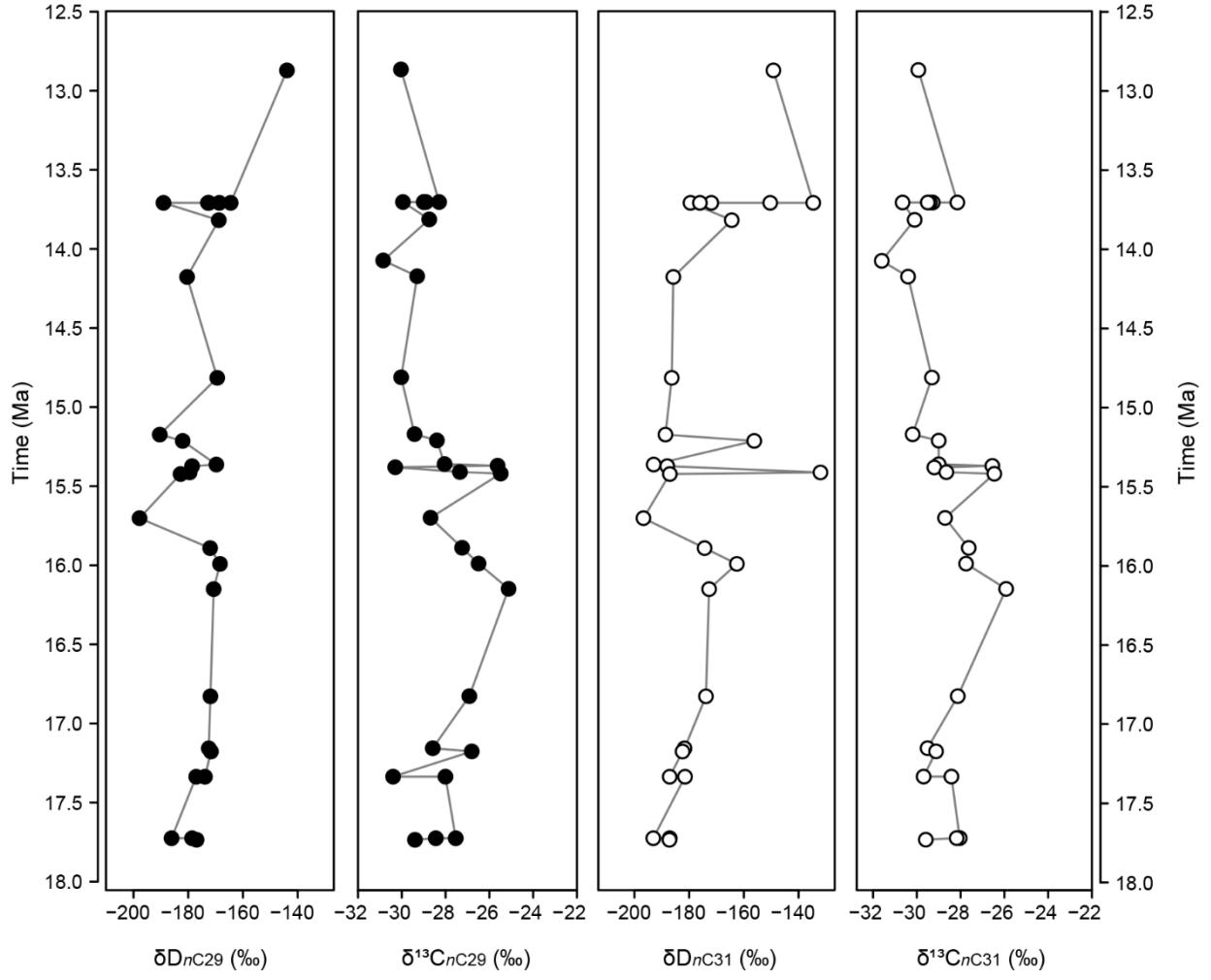


Figure DR1. Results of  $\delta^{13}C_{nC29}$  and  $\delta D_{nC29}$  (closed circles) and  $\delta^{13}C_{nC31}$  and  $\delta D_{nC31}$  (open circles).

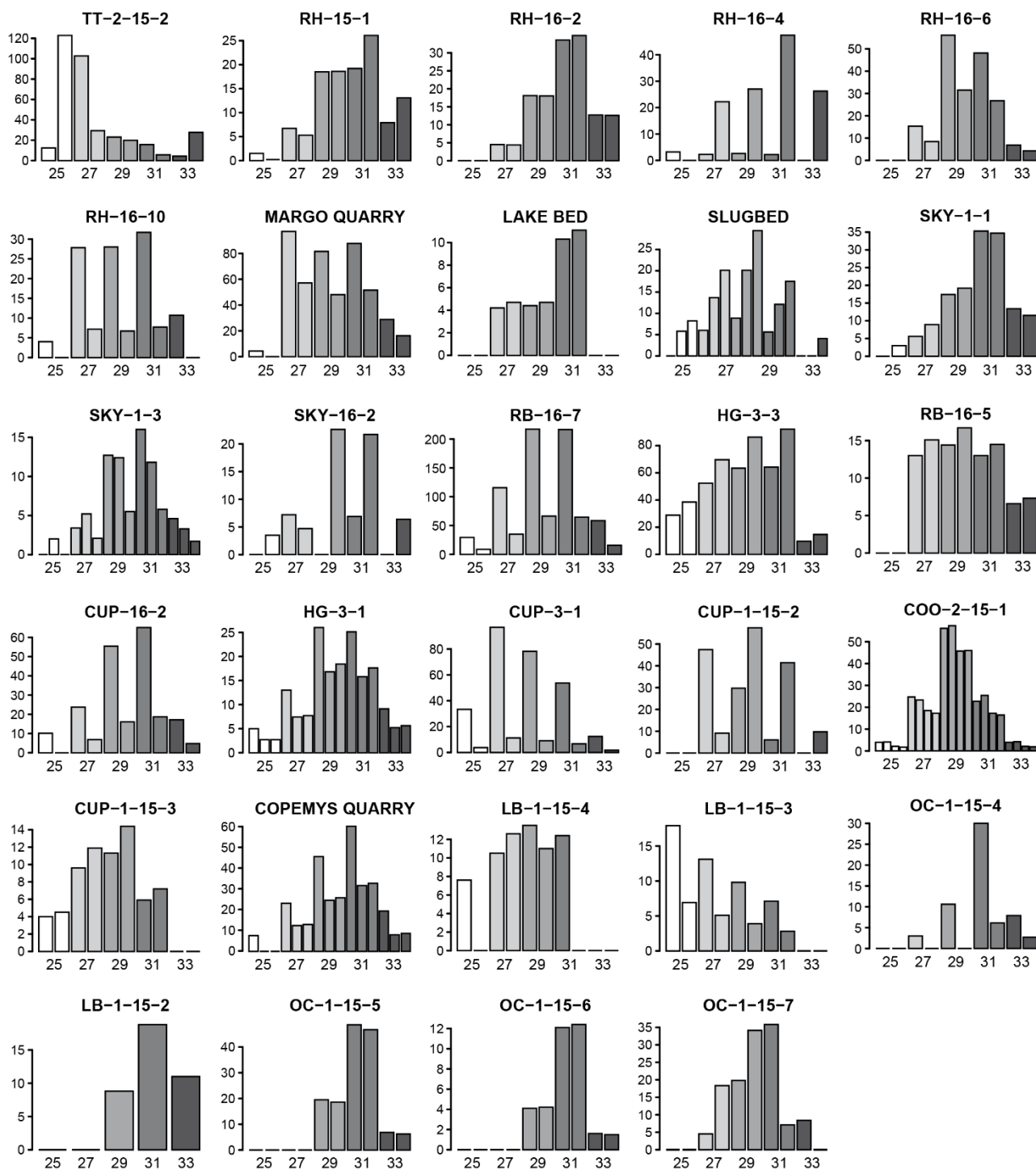


Figure DR2. Carbon-chain length abundances for  $nC_{25}$  through  $nC_{33}$  of 29  $n$ -alkane samples.

TABLE DR1. Age model of phytolith, biomarker, and soil organic matter (SOM) samples collected from the Barstow Formation. Sediment-accumulation rates (SAR) are from Loughney and Badgley (2017). Asterisks denote dated units that serve as tie points for age estimates. Coordinates are in WGS84.

Sample number	Locality name	Approximate coordinates	Composite stratigraphic level (m)	Sample type	SAR (m/Myr)	Age preferred (Ma)	Age estimate (Ma)	Reference
TT-2-6	Truck Top Quarry	35.060°, -117.103°	1129.9	Phytolith, SOM	154.1	12.86	12.864	
TT-2-7	Truck Top Quarry	35.060°, -117.103°	1129.9	Phytolith, SOM	154.1	12.86	12.864	
TT-2-15-1	Truck Top Wash	35.060°, -117.103°	1129.9	Biomarker	154.1	12.86	12.864	
TT-2-5	Truck Top Wash	35.060°, -117.103°	1069.9	Phytolith	148.66	12.94	12.541	
TT-2-4	Truck Top Wash	35.060°, -117.103°	1063.4	Phytolith	148.66	12.95	12.876	
TT-2-3	Truck Top Wash	35.060°, -117.103°	1049.2	Phytolith, SOM	148.66	12.97	12.850	
TT-2-1	Truck Top Wash	35.060°, -117.103°	1020.9	Phytolith	148.66	12.98	12.910	
TT-2-2	Truck Top Wash	35.060°, -117.103°	1002.9	Phytolith, SOM	148.66	12.99	12.992	
TT-1-15-11	Truck Top Wash	35.061°, -117.103°	999.4	Phytolith, SOM	148.66	13.02	13.015	
TT-1-15-8	Truck Top Wash	35.061°, -117.103°	998.9	Phytolith	148.66	13.02	13.019	
TT-1-2	Truck Top Wash	35.061°, -117.103°	995.4	Phytolith	148.66	13.04	13.042	
TT-1-15-1	Truck Top Wash	35.061°, -117.103°	994.5	Biomarker	148.66	13.05	13.048	
TT-1-15-2	Truck Top Wash	35.061°, -117.103°	994.5	Phytolith	148.66	13.05	13.048	
TT-1-15-3	Truck Top Wash	35.061°, -117.103°	994.5	Phytolith	148.66	13.05	13.048	
TT-1-15-4	Truck Top Wash	35.061°, -117.103°	994.5	Phytolith	148.66	13.05	13.048	
TT-1-15-5	Truck Top Wash	35.061°, -117.103°	994.5	Phytolith	148.66	13.05	13.048	
TT-1-15-6	Truck Top Wash	35.061°, -117.103°	994.5	Phytolith	148.66	13.05	13.048	
TT-1-15-7	Truck Top Wash	35.061°, -117.103°	994.5	Phytolith	148.66	13.05	13.048	
TT-1-1	Truck Top Wash	35.061°, -117.103°	993.4	Phytolith, SOM	148.66	13.06	13.055	
TT-1-15-10	Truck Top Wash	35.061°, -117.103°	990.7	Phytolith	148.66	13.07	13.074	
TT-1-15-9	Truck Top Wash	35.061°, -117.103°	981.7	Phytolith, SOM	148.66	13.21	13.211	
FW-3B-2	Falkenbach Wash	35.058°, -117.087°	953.5	Phytolith	148.66	13.26	13.327	
FW-3B-1	Falkenbach Wash	35.058°, -117.087°	948.0	Phytolith	148.66	13.30	13.299	

*Lapilli Sandstone	Hell Gate Basin		933.0			*13.40 ± 0.2		MacFadden et al. (1990)
HG-1-7	Hell Gate Basin	35.052°, -117.068°	900.0	Phytolith	111.24	13.696	13.697	
RH-16-1	Rodent Hill Basin	35.047°, -117.077°	898.0	Phytolith, SOM	148.66	13.70	13.679	
RH-16-2	Rodent Hill Basin	35.047°, -117.077°	898.0	biomarker	148.66	13.70	13.679	
RH-16-3	Rodent Hill Basin	35.047°, -117.077°	898.0	Phytolith, SOM	148.66	13.70	13.679	
RH-16-4	Rodent Hill Basin	35.047°, -117.077°	898.0	Biomarker	148.66	13.70	13.679	
RH-16-5	Rodent Hill Basin	35.047°, -117.077°	898.0	Phytolith, SOM	148.66	13.70	13.679	
RH-16-6	Rodent Hill Basin	35.047°, -117.077°	898.0	Biomarker	148.66	13.70	13.679	
RH-16-7	Rodent Hill Basin	35.047°, -117.077°	898.0	Phytolith, SOM	148.66	13.70	13.679	
RH-16-8	Rodent Hill Basin	35.047°, -117.077°	898.0	Biomarker	148.66	13.70	13.679	
RH-16-9	Rodent Hill Basin	35.047°, -117.077°	898.0	Phytolith, SOM	148.66	13.70	13.679	
RH-16-10	Rodent Hill Basin	35.047°, -117.077°	898.0	Biomarker	148.66	13.70	13.679	
RH-15-1-1	Rodent Hill Basin	35.047°, -117.077°	898.0	Phytolith, SOM	148.66	13.70	13.679	
RH-15-1-2	Rodent Hill Basin	35.047°, -117.077°	898.0	Biomarker	148.66	13.70	13.679	
OC-2-9	Owl Canyon	35.022°, -117.024°	895.5	Phytolith, SOM	119.85	13.72	13.717	
HG-1-6	Hell Gate Basin	35.052°, -117.068°	881.0	Phytolith, SOM	119.85	13.77	13.766	
CARN-16-4	Margo Quarry	35.053°, -117.082°	875.0	Biomarker	119.85	13.81	13.816	
HG-1-4	Hell Gate Basin	35.052°, -117.068°	873.0	Phytolith, SOM	109.51	13.82	13.817	
OC-1-7	Owl Canyon	35.039°, -117.025°	867.5	Phytolith	85.08	13.87	13.866	
HG-16-7	Sunnyside Quarry	35.050°, -117.073°	860.0	Phytolith, SOM	111.24	13.94	13.937	
HG-1-3	Hell Gate Basin	35.052°, -117.068°	860.0	Phytolith	111.24	13.94	13.937	
*Hemicyon Tuff			853.0			*14.00 ± 0.1		MacFadden et al. (1990)
FW-3-11	Falkenbach Wash	35.058°, -117.087°	851.5	Phytolith	148.66	14.01	14.010	
FW-3-10	Falkenbach Wash	35.058°, -117.087°	850.5	Phytolith	148.66	14.02	14.017	
FW-1-15-2	Falkenbach Wash Quarry	35.058°, -117.084°	850.0	Biomarker	119.85	14.03	14.025	
FW-3-15-4	Falkenbach Wash	35.058°, -117.087°	846.0	Biomarker	119.85	14.06	14.058	

FE-16-7	Lake Bed Quarry	35.044°, -117.071°	843.9	Biomarker	148.66	14.07	14.067	
HG-1-2	Hell Gate Basin	35.052°, -117.068°	839.0	Phytolith	111.24	14.12	14.126	
FW-3-9	Falkenbach Wash	35.058°, -117.087°	839.0	Phytolith, SOM	111.24	14.12	14.126	
FW-3-8	Falkenbach Wash	35.058°, -117.087°	834.0	SOM	148.66	14.13	14.128	
FE-16-9	Slugbed Quarry	35.042°, -117.069°	828.3	Biomarker	148.66	14.17	14.166	
FW-3-5	Falkenbach Wash	35.058°, -117.087°	809.5	Phytolith	148.66	14.30	14.293	
FW-3-7	Falkenbach Wash	35.058°, -117.087°	811.8	Phytolith	128.53	14.32	14.321	
FW-3-6	Falkenbach Wash	35.058°, -117.087°	810.0	Phytolith, SOM	128.53	14.33	14.335	
HG-1-1	Hell Gate Basin	35.052°, -117.068°	818.0	Phytolith, SOM	100.97	14.35	14.347	
OC-1-6	Owl Canyon	35.039°, -117.025°	825.5	Phytolith	85.08	14.55	14.548	
FE-16-10	Fuller's Earth Canyon	35.041°, -117.072°	813.0	Phytolith	148.66	14.71	14.706	
FW-3-4	Falkenbach Wash	35.058°, -117.087°	800.5	Phytolith	148.66	14.79	14.790	
*Dated Tuff			799.0			*14.80 ± 0.1		MacFadden et al. (1990)
OC-2-8	Owl Canyon	35.022°, -117.024°	799.0	Phytolith	85.08	14.80	14.800	
SKY-1-1	Skyline	35.034°, -117.052°	798.1	Biomarker	85.08	14.81	14.809	
SKY-1-2	Skyline	35.034°, -117.052°	798.1	Phytolith	85.08	14.81	14.809	
FE-16-5	RAM V98004	35.042°, -117.065°	798.0	Phytolith, SOM	148.66	14.81	14.807	
FW-2-3	Falkenbach Wash	35.058°, -117.085°	776.5	Phytolith	119.85	15.15	15.146	
SKY-1-5	Skyline	35.034°, -117.052°	775.9	Biomarker	119.85	15.15	15.146	
SKY-1-4	Skyline	35.034°, -117.052°	774.4	Phytolith, SOM	119.85	15.16	15.163	
SKY-1-3	Skyline	35.034°, -117.052°	773.9	Biomarker	119.85	15.17	15.167	
FW-3-3	Falkenbach Wash	35.058°, -117.087°	773.5	Phytolith	119.85	15.17	15.171	
FW-3-2	Falkenbach Wash	35.058°, -117.087°	771.5	Phytolith, SOM	119.85	15.19	15.187	
*Skyline Tuff			770.0			*15.20		D.M. Miller, written commun., April, 2016
OC-2-7	Owl Canyon	35.022°, -117.024°	770.0	Phytolith, SOM	72.5	15.20	15.200	
FW-1-1	Falkenbach Wash	35.058°, -117.084°	769.8	Phytolith, SOM	119.85	15.20	15.202	
FW-2-2	Falkenbach Wash	35.058°, -117.085°	769.7	Phytolith	119.85	15.20	15.203	



SKY-16-2	Skyline Quarry	35.034°, -117.052°	768.0	Biomarker	327.57	15.21	15.206	
FW-3-1	Falkenbach Wash	35.058°, -117.087°	764.8	Phytolith	119.85	15.24	15.243	
RB-16-7	Saucer Butte	35.034°, -117.033°	740.0	Biomarker	204.13	15.30	15.347	
FW-2-15-3	Falkenbach Wash	35.058°, -117.085°	755.5	Phytolith, SOM	119.85	15.32	15.321	
FW-2-15-4	Falkenbach Wash	35.058°, -117.085°	755.5	Biomarker	119.85	15.32	15.321	
FW-2-15-2	Falkenbach Wash	35.058°, -117.085°	755.0	Phytolith	119.85	15.32	15.325	
FW-2-15-1	Falkenbach Wash	35.058°, -117.085°	751.5	Phytolith, SOM	119.85	15.33	15.354	
OC-2-6	Owl Canyon	35.022°, -117.024°	731.0	Phytolith, SOM	286.19	15.34	15.336	
HG-3-4	Hell Gate Basin	35.053°, -117.066°	715.7	Phytolith	100.97	15.37	15.360	
HG-3-3	Hell Gate Basin	35.053°, -117.066°	715.3	Biomarker	100.97	15.37	15.364	
RB-16-5-1	Valley View Quarry	35.030°, -117.042°	710.0	Biomarker	327.57	15.38	15.383	
RB-16-5-2	Valley View Quarry	35.030°, -117.042°	710.0	SOM	327.57	15.38	15.383	
OC-2-5	Owl Canyon	35.022°, -117.024°	694.0	Phytolith, SOM	327.57	15.387	15.432	
CUP-16-5-1	RAM V94179	35.031°, -117.051°	700	SOM	327.57	15.41	15.414	
CUP-16-5-2	RAM V94179	35.031°, -117.051°	700.0	Biomarker	327.57	15.41	15.414	
HG-3-1	Hell Gate Basin	35.053°, -117.066°	696.1	Biomarker	111.24	15.42	15.419	
HG-3-2	Hell Gate Basin	35.053°, -117.066°	696.1	Phytolith, SOM	111.24	15.42	15.419	
OC-2-4	Owl Canyon	35.022°, -117.024°	637.0	Phytolith	580.83	15.46	15.429	
OC-2-3	Owl Canyon	35.022°, -117.024°	610.5	Phytolith, SOM	580.83	15.50	15.473	
OC-2-1	Owl Canyon	35.022°, -117.024°	524.0	Phytolith, SOM	580.83	15.70	15.622	
CUP-3-1	Camp Quarry	35.027°, -117.048°	523.5	Biomarker	286.19	15.70	15.704	
CUP-3-2	Camp Quarry	35.027°, -117.048°	523.5	Phytolith, SOM	286.19	15.70	15.704	
*Oreodont Tuff			496.0			*15.80 ± 0.2		MacFadden et al. (1990)
CUP-1-14	Cal-Uranium Prospect Canyon	35.025°, -117.048°	482.0	Phytolith	286.19	15.85	15.849	
CUP-1-13	Cal-Uranium Prospect Canyon	35.025°, -117.048°	480.2	Phytolith, SOM	286.19	15.86	15.855	
CUP-1-12	Cal-Uranium Prospect Canyon	35.025°, -117.048°	469.0	Phytolith	286.19	15.89	15.894	

CUP-1-15-2	Cal-Uranium Prospect Canyon	35.025°, -117.048°	469.0	Biomarker	286.19	15.89	15.894	
CUP-1-11	Cal-Uranium Prospect Canyon	35.025°, -117.048°	468.0	Phytolith	286.19	15.91	15.898	
CUP-1-9	Cal-Uranium Prospect Canyon	35.025°, -117.048°	459.0	Phytolith, SOM	286.19	15.93	15.929	
CUP-1-8	Cal-Uranium Prospect Canyon	35.025°, -117.048°	457.0	Phytolith	286.19	15.94	15.936	
COO-2-15-2	Steepside Quarry	35.032°, -117.060°	456.0	Phytolith	204.13	15.99	15.996	
COO-2-15-1	Steepside Quarry	35.032°, -117.060°	456.0	Biomarker	204.13	15.99	15.996	
CUP-1-7	Cal-Uranium Prospect Canyon	35.025°, -117.048°	425.5	Phytolith	286.19	16.05	16.046	
CUP-1-6	Cal-Uranium Prospect Canyon	35.025°, -117.048°	399.0	Phytolith	286.19	16.14	16.139	
CUP-1-15-3	Cal-Uranium Prospect Canyon	35.025°, -117.048°	394.5	Biomarker	286.19	16.15	16.155	
CUP-1-18	Cal-Uranium Prospect Canyon	35.025°, -117.048°	390.5	SOM	286.19	16.17	16.169	
CUP-1-5	Cal-Uranium Prospect Canyon	35.025°, -117.048°	373.0	Phytolith, SOM	286.19	16.23	16.230	
CUP-1-5 alt	Cal-Uranium Prospect Canyon	35.025°, -117.048°	373.0	Phytolith	286.19	16.23	16.230	
CUP-1-4-2	Cal-Uranium Prospect Canyon	35.025°, -117.048°	360.0	Phytolith, SOM	286.19	16.28	16.275	
*Rak Tuff			198.0		286.19	*16.30 ± 0.3		MacFadden et al. (1990)
CUP-1-4-1	Cal-Uranium Prospect Canyon	35.025°, -117.048°	340.5	Phytolith, SOM	286.19	16.34	16.343	
CUP-1-1	Cal-Uranium Prospect Canyon	35.025°, -117.048°	320.5	Phytolith	286.19	16.41	16.413	
CUP-1-15-1	Cal-Uranium Prospect Canyon	35.025°, -117.048°	316.0	Biomarker	286.19	16.42	16.429	
CUP-1-21B	Rainbow Loop Flora locality	35.025°, -117.048°	316.0	Phytolith	286.19	16.42	16.429	
COO-1-15-2	<i>Copemys</i> Quarry	35.028°, -117.067°	266.5	Phytolith, SOM	309.22	16.83	16.828	
COO-1-15-1	<i>Copemys</i> Quarry	35.028°, -117.067°	266.5	Biomarker	309.22	16.83	16.828	
*Dacite breccia			-175.0			*17.00 ± 0.5		Singleton and Gans (2008)

LB-1-11	Little Borate	34.951°, -116.820°	-170.5	Phytolith	534.69	17.02	17.005	
OC-1-5	Owl Canyon	35.039°, -117.025°	146.0	Phytolith	306.24	17.06	17.058	
RDQ-2	Red Division Quarry	35.025°, -117.058°	180.0	Biomarker	309.22	17.11	17.108	
RDQ-1	Red Division Quarry	35.025°, -117.058°	168.0	Phytolith	309.22	17.11	17.147	
OC-1-4	Owl Canyon	35.039°, -117.025°	120.5	Phytolith, SOM	306.24	17.14	17.143	
LB-1-15-4	Little Borate	34.952°, -116.820°	-252.0	Biomarker	534.69	17.16	17.160	
LB-1-6	Little Borate	34.952°, -116.821°	-252.0	Phytolith	534.69	17.16	17.160	
RDQ-3	Red Division Quarry	35.025°, -117.058°	163.0	Phytolith	309.22	17.16	17.163	
RDQ-4	Red Division Quarry	35.025°, -117.058°	163.0	Biomarker	309.22	17.16	17.163	
LB-1-15-3	Little Borate	34.953°, -116.819°	-262.0	Biomarker	534.69	17.18	17.178	
LB-1-5	Little Borate	34.952°, -116.820°	-262.0	Phytolith, SOM	534.69	17.18	17.178	
LB-1-3	Little Borate	34.953°, -116.819°	-295.5	Phytolith	534.69	17.24	17.225	
LB-1-2	Little Borate	34.954°, -116.819°	-306.5	Phytolith	534.69	17.26	17.261	
OC-1-15-1	Owl Canyon	35.039°, -117.025°	69.0	Phytolith	309.22	17.29	17.291	
OC-1-15-2	Owl Canyon	35.039°, -117.025°	69.0	Phytolith, SOM	309.22	17.29	17.291	
OC-1-15-3	Owl Canyon	35.039°, -117.025°	68.0	Biomarker	309.22	17.29	17.294	
OC-1-3	Owl Canyon	35.039°, -117.025°	69.0	Phytolith, SOM	309.22	17.29	17.291	
OC-1-15-4	Owl Canyon	35.039°, -117.025°	54.0	Biomarker	309.22	17.34	17.339	
OC-1-2	Owl Canyon	35.039°, -117.025°	54.0	Phytolith	309.22	17.34	17.341	
OC-1-1 B	Owl Canyon	35.039°, -117.025°	53.5	Phytolith, SOM	309.22	17.34	17.341	
LB-1-15-2	Little Borate	34.954°, -116.817°	-352.0	Biomarker	534.69	17.34	17.347	
LB-1-1	Little Borate	34.954°, -116.817°	-352.0	Phytolith	534.69	17.35	17.347	
LB-1-15-1	Little Borate	34.955°, -116.813°	-463.5	Phytolith	534.69	17.55	17.555	
LB-1-9	Little Borate	34.955°, -116.813°	-463.5	Phytolith, SOM	534.69	17.55	17.555	
LB-1-8	Little Borate	34.955°, -116.813°	-488.0	Phytolith	534.69	17.60	17.599	
*Calico tuff	Little Borate		-487.5			*17.60 ± 0.2		Miller et al. (2013)
OC-1-15-5	Owl Canyon	35.039°, -117.025°	-67.5	Biomarker	309.22	17.73	17.731	
OC-1-15-6	Owl Canyon	35.039°, -117.025°	-67.5	Biomarker	309.22	17.73	17.731	
OC-1-15-7	Owl Canyon	35.039°, -117.025°	-69.0	Biomarker	309.22	17.74	17.738	

TABLE DR3. Ecological tolerances and affinities of diatom taxa identified in phytolith samples from the Barstow Formation. Compiled from Lohman (1957), Lowe (1974), Gasse (1987), Round et al. (1990), Spaulding et al. (2010), Lange-Bertalot et al. (2011), Beals and Potapova (2013), and Owen et al. (2004).

Taxon	Habitat tolerances	Ecology	Preferred environment
<i>Anomoeoneis</i> sp.	pH: 7 to >8.5 Hypersaline to freshwater Eutrophic to oligotrophic	Epipellic, periphytic Rheophilic to indifferent	Lakes, ponds, streams, and intermittent pools
<i>Aulacoseira granulata</i>	pH: 7 to 8.5 Freshwater (some salt) Eutrophic	Planktonic	Ponds and lakes
<i>Caloneis bacillum</i>	pH: 7 to 8.5 Brackish to freshwater (some salt)	Benthic, periphytic	Streams, springs, intermittent wetlands
<i>Cymboplectura</i> cf. <i>heinii</i>	Freshwater	Benthic, epipellic	Ponds and lakes
<i>Epithemia adnata</i>	pH: 7 to >8.5 Freshwater (some salt)	Epiphytic, periphytic, Rheophilic to limnophilic	Streams, ponds, and lakes
<i>Eucocconeis laevis</i>	pH: ~7 Freshwater Oligotrophic	Benthic, epipellic	Ponds and lakes
<i>Eunotia</i> cf. <i>arcuoides</i>	pH: 5.5 to ~7 Freshwater (no salt to some salt) Eutrophic to oligotrophic	Periphytic Limnobiontic to aerophilic	Lakes, ponds, and soil
<i>Fragilaria nevadensis</i>	pH: 7 to 8.5 Freshwater (no salt to some salt) Eutrophic to mesotrophic	Periphytic, epilithic, planktonic Limnobiontic to indifferent	Streams, lakes, ponds, and springs
? <i>Frustulia</i>	Freshwater (no salt to some salt)	Benthic, periphytic	Streams, lakes, and bogs
<i>Hantzschia amphioxys</i>	pH: 7 to 8.5 Freshwater (some salt)	Periphytic, aerophilic	Ephemeral pools, moist soil
<i>Hippodonta</i> cf. <i>coxiae</i>	Freshwater (some salt)	Benthic	Ponds and lakes
<i>Luticola mutica</i>	pH: 6.5 to 8.5 Freshwater (no salt to some salt) Eutrophic to mesotrophic	Periphytic, aerophilic	Streams, springs, and moist soil
<i>Nitzschia recta</i>	pH: >7 Freshwater (some salt)	Epipellic	Ponds and lakes
<i>Nitzschia</i> , large form	pH: 7 to >8.5 Freshwater (some salt)	Periphytic, rheophilic, crenophilic, or limnophilic	Streams, springs, ponds, and lakes
<i>Nitzschia</i> or <i>Hantzschia</i>	pH: >7 Freshwater (some salt)		Streams, ponds, lakes, or soil
<i>Pinnularia borealis</i>	pH: ~7 Freshwater (some salt) Eutrophic	Periphytic, aerophilic	Streams, ponds, lakes, and soil
<i>Pinnularia brebissonii</i>	pH: <7 to >7 Freshwater	Benthic	Ponds, lakes, and marshes
<i>Sellaphora bacilloides</i>	pH: ~7 Freshwater	Benthic	Ponds, lakes, and low-gradient streams

TABLE DR4. Phytolith and isotopic results of six samples collected along a 106-m lateral transect in the Upper Member of the Barstow Formation. Percentage of forest indicator (FI), grass silica short cell (GSSC), and C<sub>4</sub> phytolith morphotypes, average chain length (ACL),  $\delta^{13}\text{C}_{nC27-31}$ ,  $\delta\text{D}_{nC27-31}$ , and  $\delta^{13}\text{C}_{\text{SOM}}$  are given for each sample.

Sample	FI (%) <sup>*</sup>	GSSC (%) <sup>*</sup>	C <sub>4</sub> GSSC (%) <sup>†</sup>	ACL	$\delta^{13}\text{C}_{nC27-31}$	$\delta\text{D}_{nC27-31}$	$\delta^{13}\text{C}_{\text{SOM}}$
RH-15-1	30.5	69.1	26.0	30.2	-29.0	-175.5	-18.5
RH-16-1	33.3	66.5	11.7	30.6	-29.2	-164.9	-21.9
RH-16-3	23.6	75.8	7.9	29.1	-28.3	-179.3	-22.1
RH-16-5	-	-	-	29.8	-30.3	-172.5	-21.6
RH-16-7	76.9	22.8	3.3	-	-	-	-22.1
RH-16-9	-	-	-	29.2	-29.3	-163.5	-22.5

<sup>\*</sup>Percent of phytolith count total  
<sup>†</sup>Percent of GSSC total

TABLE DR5. Carbon isotope results from soil organic matter, weight-percent carbon, estimated age of sample, and reconstructed atmospheric  $\delta^{13}\text{C}$  from Tipple et al. (2010). Reprocessed samples are indicated by number of runs, samples not included in results are in gray.

Sample No.	Member	Age (Ma)	$\delta^{13}\text{C}_{\text{VPDB}}$ (‰)	Weight % C	$\delta^{13}\text{C}_{\text{atm}}$ (‰)
TT-2-6	Upper	12.86	-19.34	0.03	-5.93
TT-2-7	Upper	12.86	-22.19	0.03	-5.93
TT-2-3	Upper	12.97	-23.64	0.02	-5.91
TT-2-2	Upper	12.99	-23.63	0.05	-5.91
TT-1-15-11	Upper	13.02	-23.07	0.02	-5.91
TT-1-1	Upper	13.06	-21.16	0.03	-5.91
TT-1-15-9	Upper	13.21	-21.44	0.04	-5.90
RH-15-1 run 1	Upper	13.69	-18.52	0.06	-5.80
RH-15-1 run 2	Upper	13.69	-16.85	0.04	-5.80
RH-16-1	Upper	13.69	-21.92	0.04	-5.80
RH-16-3	Upper	13.69	-22.07	0.04	-5.80
RH-16-5	Upper	13.69	-21.64	0.07	-5.80
RH-16-7	Upper	13.69	-22.08	0.05	-5.80
RH-16-9	Upper	13.69	-22.48	0.06	-5.80
OC-2-9	Upper	13.72	-21.95	0.13	-5.79
HG-1-6 run 1	Upper	13.77	-18.18	0.19	-5.79
HG-1-6 run 2	Upper	13.77	-20.49	0.07	-5.79
HG-1-4	Upper	13.82	-20.66	0.12	-5.77
HG-16-7	Upper	13.94	-24.74	0.04	-5.74
FW-3-9	Upper	14.12	-22.84	0.05	-5.66
FW-3-8	Upper	14.13	-21.26	0.09	-5.65
FW-3-6	Upper	14.33	-25.53	0.04	-5.55
HG-1-1	Upper	14.35	-23.82	0.06	-5.53
FE-16-5	Upper	14.81	-23.34	0.02	-5.29
SKY-1-4	Upper	15.16	-22.86	0.02	-5.27
FW-3-2	Upper	15.19	-26.08	0.08	-5.27
OC-2-7	Upper	15.20	-24.57	0.14	-5.27
FW-1-1	Upper	15.20	-24.51	0.05	-5.27
FW-2-15-3	Middle	15.32	-24.03	0.04	-5.27
FW-2-15-1	Middle	15.33	-23.22	0.11	-5.26
OC-2-6	Middle	15.34	-21.41	0.12	-5.26
OC-2-5	Middle	15.39	-20.62	0.08	-5.26
CUP-16-5-1	Middle	15.41	-23.23	0.03	-5.26
HG-3-2	Middle	15.42	-23.09	0.12	-5.27
OC-2-3	Middle	15.50	-24.65	0.12	-5.25
OC-2-1	Middle	15.70	-22.89	0.07	-5.26
CUP-3-2	Middle	15.70	-21.33	0.27	-5.26
CUP-1-13	Middle	15.86	-23.34	0.03	-5.26
CUP-1-9	Middle	15.93	-22.84	0.07	-5.29
CUP-1-5	Middle	16.23	-22.29	0.17	-5.33
CUP-1-4-2	Middle	16.28	-24.13	0.03	-5.32
CUP-1-4-1	Middle	16.34	-22.97	0.04	-5.34
COO-1-15-2	Owl Congl.	16.83	-23.73	0.04	-5.40
RDQ-1	Owl Congl.	17.11	-23.57	0.02	-5.44
OC-1-4	Owl Congl.	17.14	-25.11	0.06	-5.44

LB-1-5	Calico	17.18	-22.34	0.16	-5.44
OC-1-15-2	Owl Congl.	17.29	-23.66	0.04	-5.49
OC-1-3	Owl Congl.	17.29	-22.05	0.03	-5.59
OC-1-1B	Owl Congl.	17.34	-22.92	0.04	-5.51
LB-1-9	Calico	17.55	-20.39	0.05	-5.61