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Supplemental Material

Table S1. Coring locations, site data, and geologic environment.

Table S2. Chemical data from electron microprobe analyses of glass grains from Yellowstone tephra samples and from established standard samples of Mazama tephra, Glacier Peak tephra, and Yellowstone rhyolites.

Table S3. Characteristics of limnic facies in sediments from Yellowstone Lake, Wyoming, USA, modified after Tiller (1995).

Table S4. Estimates of deposit volumes from the Mary Bay and Elliott's Crater hydrothermal explosions and energy produced.

TABLE S1. CORING LOCATIONS, SITE DATA, AND GEOLOGIC ENVIRONMENT

Sediment cores	Location		Core length (m)	Water depth (m)	Geologic environment	Distance to Mary Bay (km)	Distance to Elliott's Crater (km)	Map
	Latitude (°N)	Longitude (°W)						
Piston Cores								
YL16-1A-1K (1-4)	44.53971	110.35315	4.21	20	hydrothermal dome	3.4	N.A.	Illinois[1]
YL16-2A-1K (1-7)	44.53927	110.38922	8.71	61	active graben	6.3	5.2	USGS[2]
YL16-2C-1K (1-10)	44.53927	110.38922	11.62	61	active graben	6.3	5.2	USGS[2]
YL16-3A-1K (1-10)	44.50722	110.35642	10.28	87	Deep Hole vent field	5.5	3.7	Illinois[1]
YL16-4A-1K (1-8)	44.53264	110.32492	9.71	56	Elliott's Crater	1.7	0	Illinois[1]
YL16-4C-1K (1-9)	44.53264	110.32492	11.71	56	Elliott's Crater	1.7	0	Illinois[1]
YL16-5A-1K (1-11)	44.50782	110.32685	11.02	102	deep central lake basin	4.3	2.6	Illinois[1]
YL16-6A-1K (1-7)	44.49616	110.29215	8.41	86	steep eastern shore	5.7	4.6	USGS[2]
YL92-1A-1K (1-9)	44.4390	110.3954	8.57	81.5	between Frank-Dot Islands	13.7	11.9	USGS[2]
YL92-1C-1K (1-9)	44.4390	110.3954	8.01	81.5	between Frank-Dot Islands	13.7	11.9	USGS[2]
YL92-2A-1K (1-9)	44.3856	110.3282	6.87	52	mouth of South Arm	17.9	16.2	USGS[2]
YL92-3A-1K (1-9)	44.4460	110.5483	9.15	80	West Thumb basin	22.0	20.0	USGS[2]
CUB17-1A (1-6 L)	44.50545	110.24685	5.90	fen	small pond, 2510 masl	6.5	6.3	N.D.
CUB17-1B (1-5 L)	44.50545	110.24685	5.35	fen	small pond, 2510 masl	6.5	6.3	N.D.
core from Alder Lake	44.3353	110.3128	10.5	fen	Alder Lake, Promontory, 3 m above South Arm	23.1	21.7	N.D.
Gravity Cores								
YL16-18A-1G	44.51172	110.35769	0.52	91	Deep Hole vents	N.A.	N.A.	Illinois[1]
YL17-10A-1G	44.50965	110.35569	0.82	100	Deep Hole vents	N.A.	N.A.	Illinois[1]
YL17-14A-1G	44.53679	110.42465	0.66	13.6	Bridge Bay area	N.A.	N.A.	Illinois[1]

Note: Illinois[1] (Cash, 2015); USGS[2] (Morgan et al., 2003, 2007a).

Note: YL92-1A-1K (1-9) also is known as FD-II (Theriot et al., 2006).

Note: description of core from Alder Lake is from Tiller (1995) after Sherrod (1989).

Note: under piston cores, the notation (1-4) refers to the numbered sections or drives in a particular piston core, top to bottom. In this example, four sections are in the core. K refers to cores collected using a Kullenberg coring device; L refers to drives collected using a Livingstone coring device. For simplicity, the piston cores are referred to in the text without the "-1K" suffix. 1G refers to short cores collected with a gravity coring device.

Note: masl: meters above sea level.

TABLE S2. CHEMICAL DATA FROM ELECTRON MICROPROBE ANALYSES OF GLASS GRAINS FROM YELLOWSTONE TEPHRA SAMPLES AND ESTABLISHED STANDARD SAMPLES OF MAZAMA TEPHRA, GLACIER PEAK TEPHRA, AND YELLOWSTONE RHYOLITES

Sample number (total depth in core)	location	Source	Age (ka)	N	SiO_2	TiO_2	Al_2O_3	MgO	CaO	MnO	FeO	Na_2O	K_2O	P_2O_5	SO_2	F	Cl	Description
Mazama samples																		
YL92-1A-1K-6 (5.08 m)	Frank-Dot Islands	Mazama	7.6	14	72.6	0.41	14.35	0.41	1.74	0.06	1.93	5.32	2.77	0.06	0.02	0.11	0.17	Fine-grained vesicular, angular
YL16-2C-1K-8-W (9.35 m)	Lake Hotel Graben	Mazama	7.6	9	72.8	0.45	14.22	0.43	1.64	0.05	2.00	5.25	2.84	0.07	0.01	0.10	0.17	Uniform particle distribution, angular
YL16-5A-1K-8 (7.79 m)	Central Basin	Mazama	7.6	12	72.8	0.42	14.20	0.43	1.64	0.06	2.03	5.28	2.79	0.06	0.02	0.11	0.19	Clean, angular particles
YL92-1C-1K-7-W (5.25 m)	Frank-Dot Islands	Mazama	7.6	9	72.8	0.41	14.25	0.42	1.62	0.05	1.99	5.24	2.77	0.08	0.01	0.11	0.19	Fine-grained vesicular, angular
YL16-3A-1K-8-W (7.86 m)	Deep Hole	Mazama	7.6	14	72.9	0.43	14.15	0.44	1.65	0.05	2.01	5.22	2.82	0.06	0.02	0.11	0.17	Uniform particle distribution, angular
YL92-2A-1K-5 (4.22 m)	South Arm	Mazama	7.6	13	72.9	0.45	14.22	0.42	1.60	0.06	1.98	5.26	2.76	0.06	0.02	0.09	0.18	Fine, vesicular with very fine- grained particles
YL16-6A-1K-6 (6.19 m)	Mud slumps	Mazama	7.6	4	72.9	0.43	14.10	0.47	1.58	0.08	1.99	5.19	2.82	0.08	0.01	0.12	0.21	Lots of diatoms, less angular particles
YL16-4A-1K-7 (7.97 m)	Elliott's Crater	Mazama	7.6	12	73.3	0.39	13.93	0.39	1.54	0.05	1.98	4.99	3.01	0.06	0.02	0.12	0.18	Fine-grained, vesicular, some diatoms
YL16-4C-1K-7 (8.2 m)	Elliott's Crater	Mazama	7.6	10	73.5	0.37	13.90	0.38	1.49	0.05	1.93	4.91	3.08	0.06	0.01	0.13	0.17	Fine-grained, vesicular, some diatoms
YL92-3A-1K-8 (7.69 m)	West Thumb	Mazama	7.6	12	73.5	0.43	14.31	0.43	1.65	0.06	2.02	4.35	2.81	0.06	0.02	0.12	0.23	Fine-grained vesicular, angular
Mazama standard																		
UA2832	*N.A.*	*Mazama*	7.6	*62*	*72.8*	*0.44*	*14.73*	*0.47*	*1.64*	*0.05*	*2.01*	*4.88*	*2.77*	*N.D.*	*N.D.*	*N.D.*	*0.18*	Jensen and Beaudoin, 2016
Glacier Peak samples																		
YL92-1A-1K-9 (8.62 m)	Frank-Dot Islands	Glacier Peak	13.6	6	77.3	0.20	12.39	0.22	1.28	0.04	1.16	3.87	3.24	0.04	0.02	0.09	0.19	Mixed particles, vesicular and blocky

YL16-1A-1K-2 (1.98 m)	hydrothermal dome	Glacier Peak	13.6	8	77.3	0.20	12.37	0.29	1.32	0.03	1.31	3.17	3.36	0.04	0.03	0.08	0.49	Mixed appearance, vesicular and blocky
CUB17-1B-4L-1 (8.55 m)	Cub Creek Pond	Glacier Peak	13.6	11	77.3	0.19	12.43	0.22	1.36	0.04	1.13	3.80	3.26	0.04	0.01	0.07	0.19	Fine-grained, vesicular and blocky
Glacier Peak standards																		
GP-G	*N.A.*	*Glacier Peak*	13.6		*77.4*	*0.18*	*12.73*	*0.23*	*1.21*	*0.04*	*1.03*	*3.62*	*3.39*	*N.D.*	*N.D.*	*N.D.*	*0.15*	Kuehn et al., 2009
GP-B	*N.A.*	*Glacier Peak*	13.6		*77.2*	*0.21*	*12.78*	*0.27*	*1.41*	*0.04*	*1.15*	*3.72*	*3.00*	*N.D.*	*N.D.*	*N.D.*	*0.19*	Kuehn et al., 2009
GP-M	*N.A.*	*Glacier Peak*	13.6		*77.3*	*0.21*	*12.72*	*0.26*	*1.35*	*0.03*	*1.11*	*3.82*	*3.02*	*N.D.*	*N.D.*	*N.D.*	*0.18*	Kuehn et al., 2009
Reworked ash sample																		
YL16-6A-1K-6 (6.30 m)	Mud slumps	Reworked Yellowstone ash		4	78.3	0.15	11.25	0.07	0.49	0.03	1.15	3.3	4.75	0.02	0.06	0.17	0.32	
Yellowstone rhyolites																		
Yellowstone (6YC-113)	*N.A.*	*Yellowstone*	*600*		*76.4*	*0.14*	*12.09*	*0.03*	*0.45*	*0.04*	*1.46*	*3.55*	*5.16*				*0.08*	Christiansen, 2001
Yellowstone (7YC-271)	*N.A.*	*Yellowstone*	*2050*		*73.6*	*0.16*	*12.45*	*0.04*	*0.43*	*0.06*	*1.53*	*3.09*	*5.04*			*0.15*	*0.07*	Christiansen, 2001
Yellowstone (YS57F)	*N.A.*	*Yellowstone*	*600*		*77.2*	*0.18*	*12.24*	*0.03*	*0.51*	*0.02*	*1.46*	*3.18*	*5.22*		*0.01*			Christiansen, 2001

Notes: N= number of analyses. Electron microprobe accelerating voltage of 15kV and a probe current of 10 nA were used. All analyses normalized to 100% on a water-free basis.
Data are available from New Mexico Institute of Mining and Technology. Contact Nels Iverson (nels.iverson@nmt.edu) for further information.

TABLE S3. CHARACTERISTICS OF LIMNIC FACIES IN SEDIMENTS FROM YELLOWSTONE LAKE, WYOMING, USA

Lithofacies code (youngest (IX) to oldest (0))	Description	Thick-ness (cm)	Color	Stratification	Diatom Population	Bioturbation	MS, C, BSi	Interpretation
IX	Variably mottled or banded, diatomaceous mud; laminae not visible.	50-300	Olive gray	Low to very low	High concentration of large diatoms (*Stephanodiscus yellowstonesis*, *Asterionella formosa*, benthics)	Some	Moderate MS values increasing upward, high C content decreasing upward, high BSi content decreasing upward	Water column instability and turbulence resulting in high nutrient supply.
VIII	Intermittently weakly laminated, variably mottled, or banded diatomaceous mud.	90-225	Olive gray	Low to intermediate	N.D.	Moderate	Low MS (50-100 SI), very high C (2.5-4%), very high BSi (50-55%)	Greatest bottom water oxygen availability and least water column stability.
VII	Weakly laminated, banded, diatomaceous mud.	50-200	Olive gray	High to intermediate	N.D.	Absent	Very low MS (40-60 SI), high C content (2.5-5%), very high BSi (45%)	Absent in core YL92-1A and instead replaced by detrital organic-rich horizon, possible disconformity.
VI	Intermittently banded, mottled, diatomaceous mud.	30-475	Olive gray	Very high	N.D.	Pronounced (high oligochaete population)	Moderately high but variable MS (80-150 SI), C content (2-3.5%), BSi (40-50%), minor sulfides	Greatest bottom water oxygen availability and least water column stability.
V	Interbedded laminated, mottled, diatomaceous mud. Contains Mazama ash and Elliott's Crater hydrothermal explosion deposit.	50-200	Olive gray	Variable	Diverse diatom community (*Aulacoseira subarctica*, large *Stephanodiscus yellowstonensis*, and benthics.	Moderate—first evidence in Yellowstone Lake sediments implying oxygenated bottom water conditions	N.D.	Diversity of diatoms suggests expansion of available habitats. Substantial populations of heavily silicified, large *Stephanodiscus yellowstonensis* implies that the water column was turbulent enough to keep diatoms suspended in water.
IV	Uniformly, well-laminated diatomaceous mud (varies from 12 laminae/cm to 8 laminae/cm, wavy).	0-110	Olive gray	Very high	N.D.	Absent	N.D.	Eutrophic. Generally stable water column, high productivity, low bottom water oxygen availability. Uniform high productivity over long time implies eutrophic conditions with nutrients supplied by an inexhaustible exterior source.
III	Pronounced laminations,	0-75	Olive	High	N.D.	Absent	Moderately high MS	High productivity and low bottom

	mottled, diatomaceous mud; contains sandy oxide concentrations.		gray				(230 SI); authigenic sulfides replaced by oxide concretions	water oxygen availability; high nutrients may be responsible for concentration of plant detritus (higher than other Yellowstone Lake units).
II	Diatom and sulfide laminated couplets, slightly clayey diatomaceous mud. Contains Mary Bay hydrothermal explosion deposit.	25-125	Olive gray	High	Abundant, rapid diatom growth	Absent	Moderately high MS (200-500 SI), low to moderate C content (1.5-3%), variable amounts of BSi, abundant authigenic sulfide (TS 1%)	Meromictic, stable water column, high productivity, and low bottom water oxygen availability; high nutrient concentrations supporting rapid diatom growth.
I	Slightly diatomaceous, faintly bedded, clayey mud, proglacial varves. Contains Glacier Peak ash.	85-100	Olive gray	Very low	Large diatoms (*Stephanodiscus yellowstonensis* and benthics)	Absent	Very high MS (>600 SI), very low C content (<1%), and BSi content (15%)	Oligotrophic, turbulent water column in unproductive lake, low nutrient availability, clastic sediments, low temperatures. Diatom population implies turbulently mixed water and low nutrient concentrations.
0	Rhythmically laminated couplets of thin (0.1-0.2 cm) dark coarser units that alternate with thicker (0.3-0.6 cm) light-colored diatom-rich units.	0-170	Olive green gray	High	N.D.	Absent	MS has relatively high and fluctuating values; high Si content increases with depth	Lake sediments in lower 2 m of YL16-1A subjected to hydrothermal alteration (silicification) associated with hydrothermal dome; small faults or fractures with minor offsets may be related to doming.

Note: MS, Magnetic Susceptibility; C, Carbon; BSi, Biogenic Silica; TS: Total Sulfide; N.D., not determined; modified after Tiller, 1995

TABLE S4. ESTIMATES OF DEPOSIT VOLUMES FROM THE MARY BAY AND ELLIOTT'S CRATER HYDROTHERMAL EXPLOSIONS AND ENERGY PRODUCED

Hydrothermal Explosion System	Crater or Deposit Area (km^2)	Thickness or depth (m)	Estimated volume (km^3)	Volume (m^3)	Explosion energy (J)*
MARY BAY DEPOSITS ON LAND					
80-m rim: Holmes Point to Steamboat Point	0.4	8	0.003		
40-m rim: Holmes Point to west end of Beach Springs	1.7	40	0.07		
broader inland mapped hydrothermal explosion breccia deposits	18	3.5	0.06		
Sum of on-land deposits	20		0.13		
MARY BAY DEPOSITS IN LAKE			`		
>50 cm	9	1.0	0.01		
>30 cm	254	0.4	0.10		
>10 cm	129	0.2	0.03		
Sum of deposits in lake	390		0.14		
MARY BAY sum of all deposits			**0.27**	$2.7x10^8$	**1.3 to 3.5 x 10^{15}**
MARY BAY CRATER					
full crater	3.6	53	0.19		
central crater	1.9	53	0.10		
Total crater depth to match ejecta volume					
full crater, conical excavation	3.6	**225**	0.27		
central crater, conical excavation	1.9	**420**	0.27		
ELLIOTT'S CRATER					
breccia lobe south-southeast from crater	1.1	10	0.01		
>2 m isopach	6	2.5	0.01		
>1 m isopach	24	1.5	0.04		
>0.02 m isopach	239	0.04	0.01		
Sum of all deposits	263		**0.07**	$7.1x10^7$	**0.4 to 0.9 x 10^{15}**
ELLIOTT'S CRATER VOLUME					
Full crater	0.4	40	0.02		
Total crater depth to match ejecta volume					
Full crater, cylindrical excavation	0.4	**180**	0.07		
Full crater, conical excavation	0.4	550	0.07		

***The ranges of explosion energy values are based on measurements of 5 to 12.9 MJ/m^3 for samples with water-filled pore spaces from 7 to 26% porosity and for explosion temperatures of 250-262°C (Montanaro et al., 2016a).