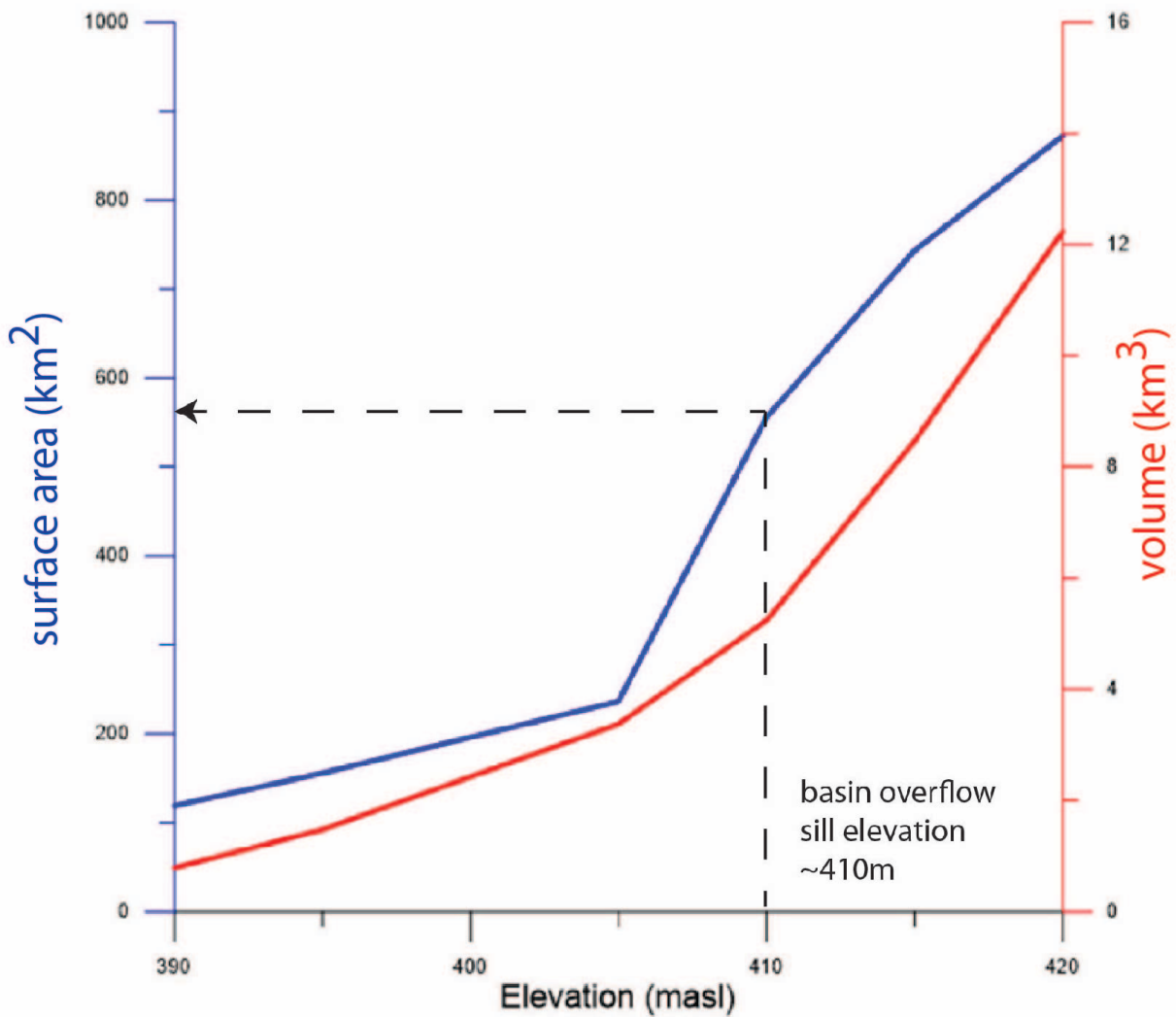
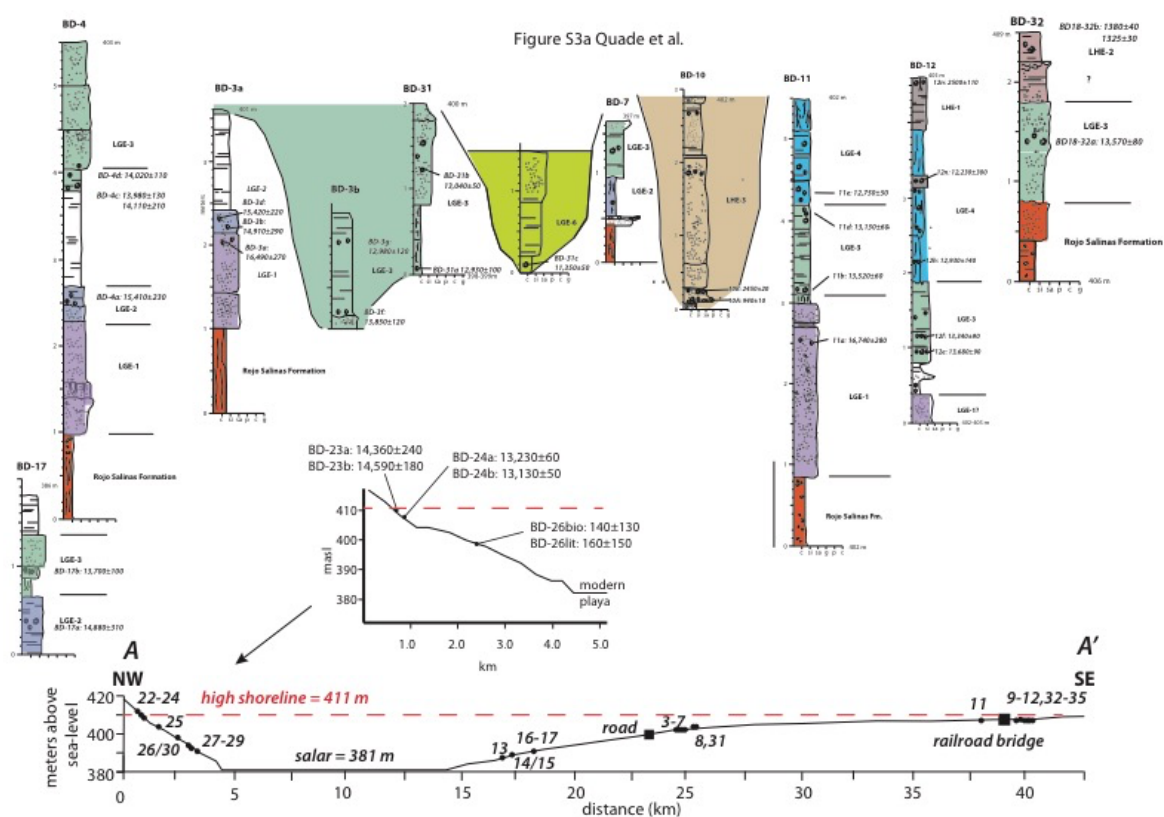


**Figure S1** Hillshaded SRTM digital elevation model (~38m/pixel) of the Salinas del Bebedero. The hydrographic basin is in purple, surrounding the salinas itself (a playa) in blue. The Sierra de San Luis, the southernmost extension of the Sierras Pampeanas, borders the NE edge of the basin.



**Figure S2** The basin hypsography of Salinas del Bebedero basin, showing the estimated paleo-lake surface area of volume versus elevation. At 382 m, the modern playa covers about 70km<sup>2</sup>, the paleolake at its highstand (and overflow point at ~410m) about 555 km<sup>2</sup>, and the overall basin 7756 km<sup>2</sup>. The calculations were made based on SRTM digital elevation model (~38m/pixel).

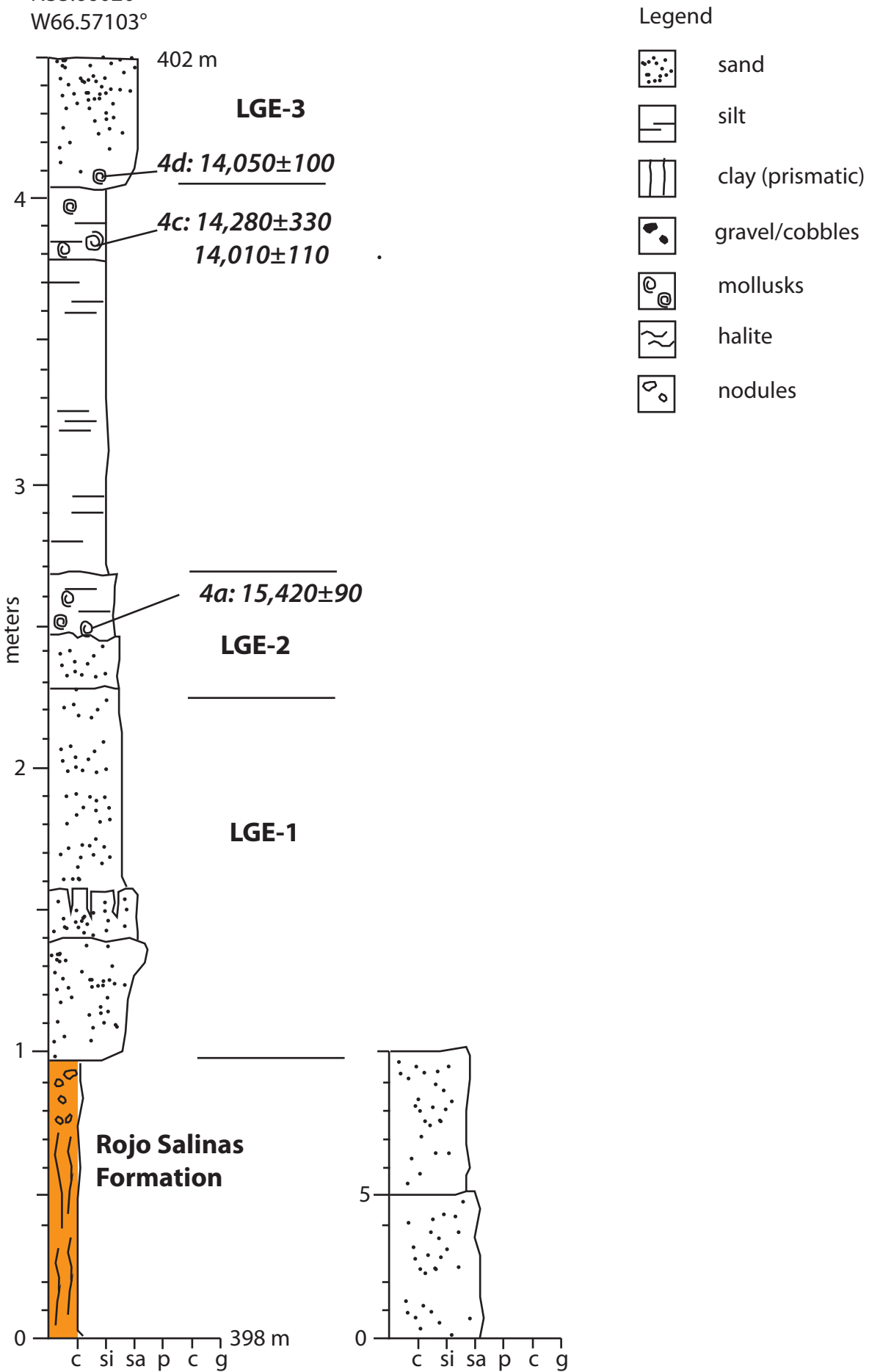


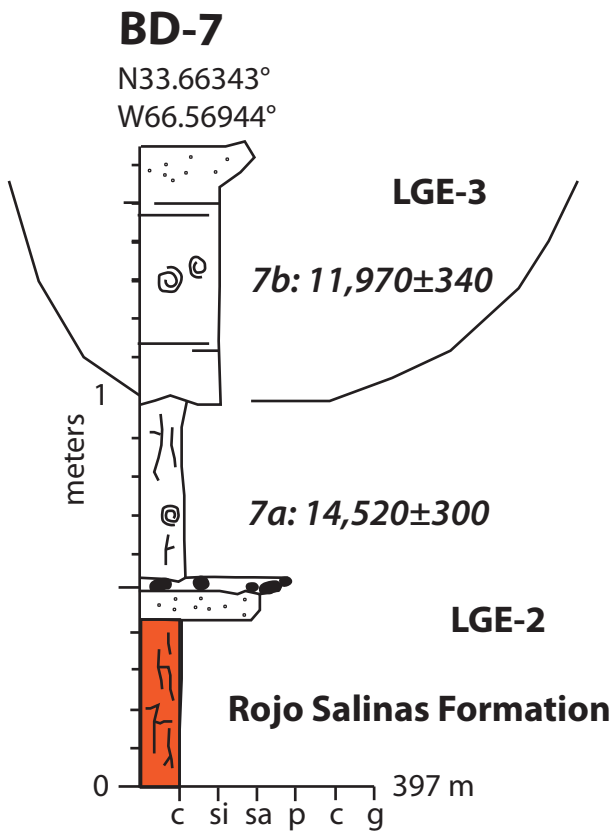
**Figure S3a.** Summary of the stratigraphy and dating of the Bebedero Formation. At bottom is a topographic profile of the basin running NW-SE across the playa, then south along Bebedero Creek (marked as a dotted line in Fig. 2; A to A'). Numbered stratigraphic sections (prefixed BD-#) mentioned in the text and supplement indicated above the profile. In the center is a detailed profile of dates obtained from shorelines in the northwest corner of the basin. Across the top are representative sections showing key stratigraphic relationships; details of each of these sections and the legend are shown in the supplement in Figure S3.

# BD-4

N33.66020°  
W66.57103°

## Figure S3b BD-4





**Figure S3c BD -7**

# BD-10

N33.76029°  
W66.57457°

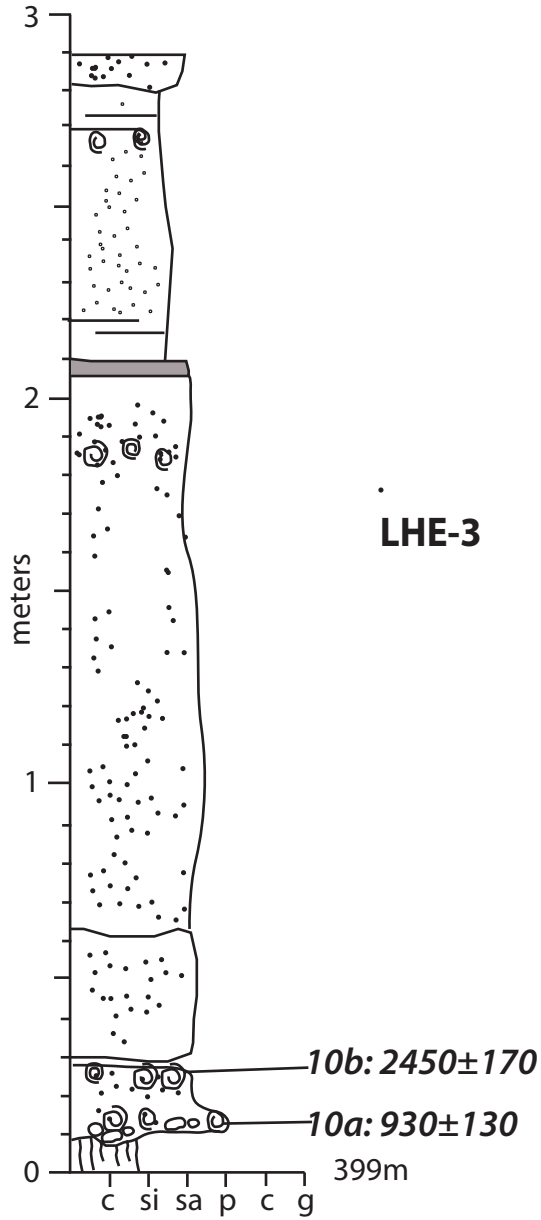
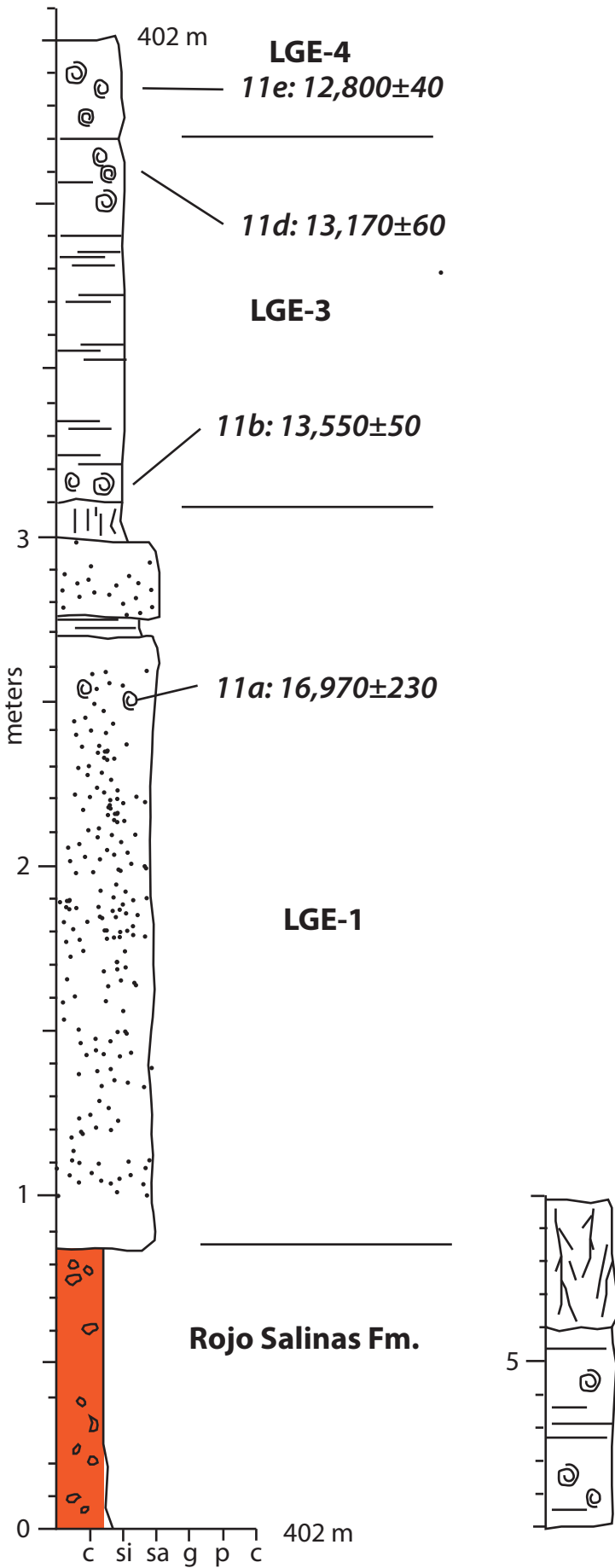


Figure S3d BD-10

# BD-11

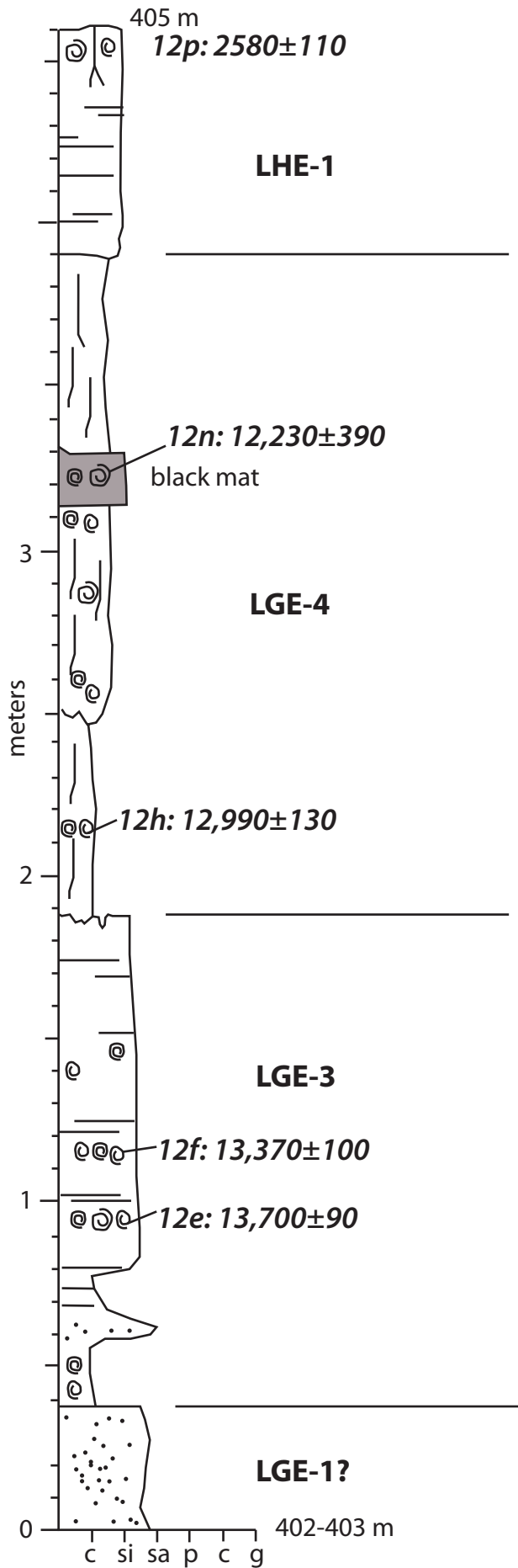
N33.75097°  
W66.57018°

Figure S3e BD-11



N33.76774°

W66.57761°



**Figure S3f BD-12**

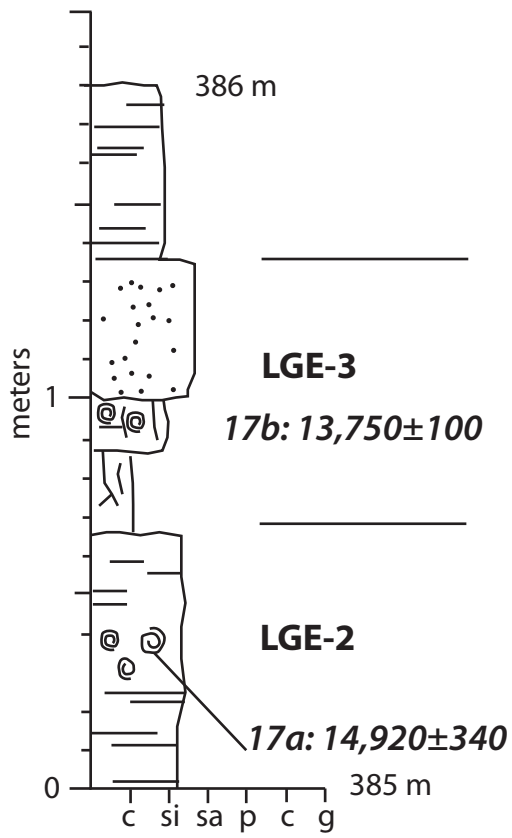


Figure S3g BD-17

**BD-17**

N33.62702°

W66.60476°



# BD-31

N33.76774°  
W66.66769°

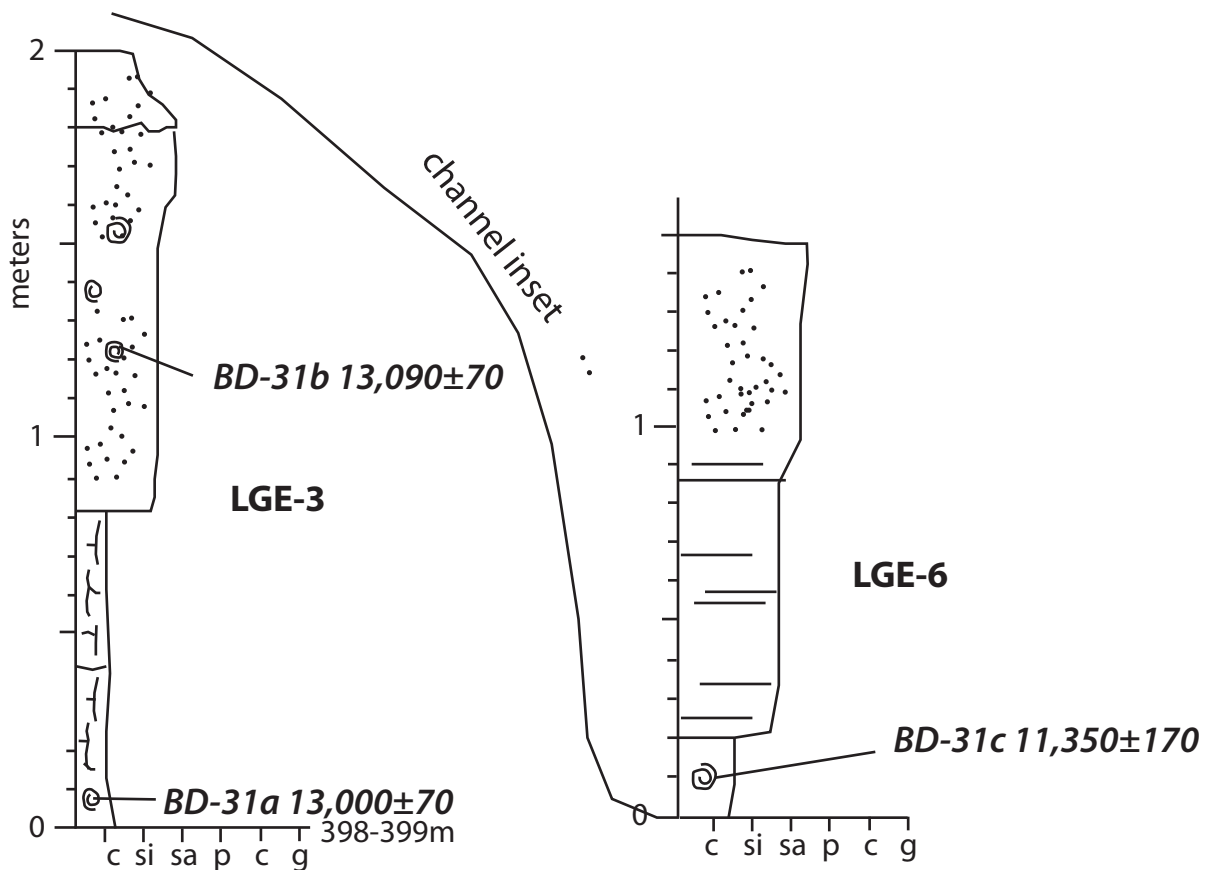
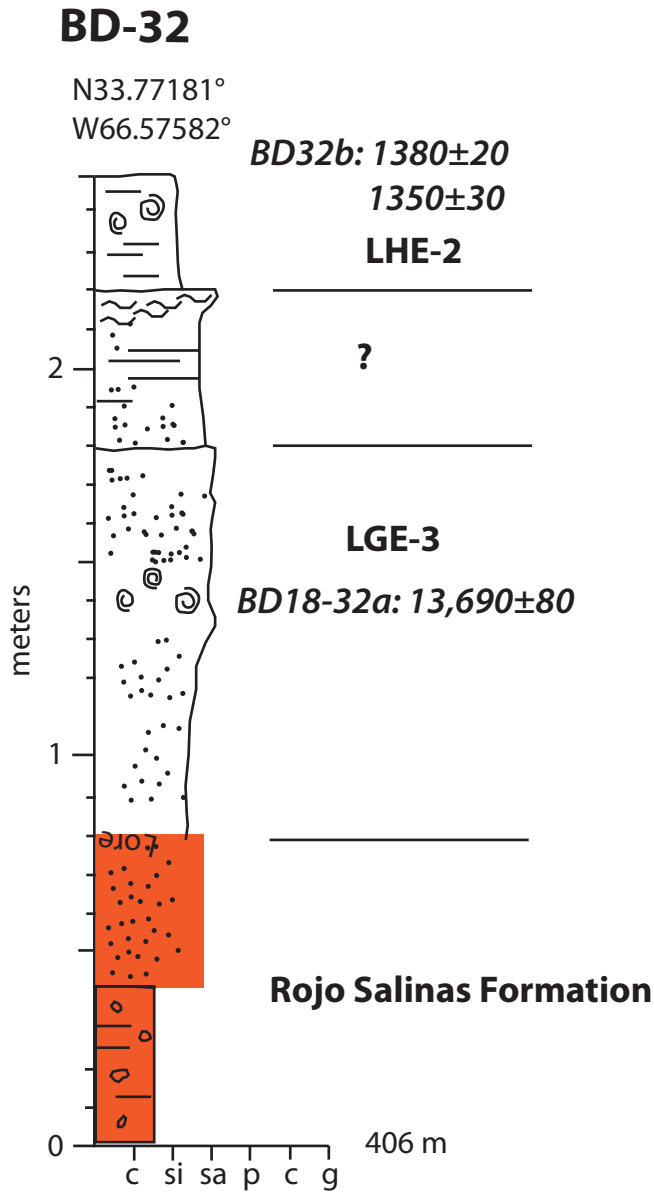


Figure S3h BD-31

Figure S3i BD-32



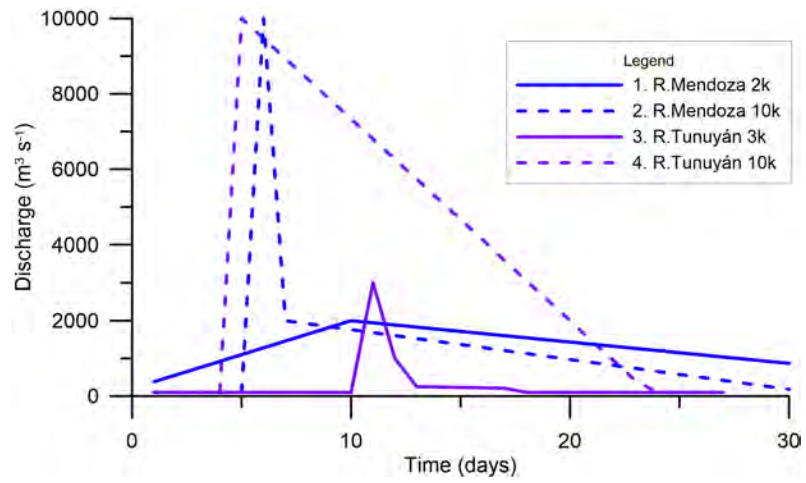


Figure S4 Hydrographs of the main model runs. “R. Mendoza 2K” denotes peak discharge = 2000 m<sup>3</sup>/sec from the Río Mendoza, and so forth. See details on input parameters in Table S3.

Table S1 U-Pb geochronologic analyses.

**Sample BD-26**

<b>Analysis</b>	<b>U (ppm)</b>	<b>Age (Ma)</b>	<b>± (Ma)</b>
BD-26 Spot 39	281	10.20	0.20
BD-26 Spot 80	158	268.13	2.39
BD-26 Spot 70	689	352.29	3.98
BD-26 Spot 3	507	371.57	3.84
BD-26 Spot 32	641	378.67	6.34
BD-26 Spot 72	830	380.50	3.44
BD-26 Spot 90	1596	381.68	4.59
BD-26 Spot 108	1038	383.48	3.32
BD-26 Spot 44	395	384.11	4.03
BD-26 Spot 33	788	389.07	4.43
BD-26 Spot 5	281	390.13	3.66
BD-26 Spot 76	441	392.11	4.13
BD-26 Spot 60	344	393.87	5.46
BD-26 Spot 89	198	394.90	3.69
BD-26 Spot 41	126	395.52	4.29
BD-26 Spot 30	204	396.65	4.14
BD-26 Spot 88	327	396.96	3.71
BD-26 Spot 59	646	397.83	3.52
BD-26 Spot 104	349	398.28	3.69
BD-26 Spot 17	484	398.77	5.39
BD-26 Spot 69	466	398.79	3.49
BD-26 Spot 96	1024	398.95	4.14
BD-26 Spot 16	616	399.26	4.54
BD-26 Spot 42	509	399.65	3.81
BD-26 Spot 21	575	399.70	4.45
BD-26 Spot 82	418	399.88	3.75
BD-26 Spot 57	681	400.59	4.08
BD-26 Spot 84	389	400.67	4.25
BD-26 Spot 0	5353	401.01	3.30
BD-26 Spot 53	168	401.56	3.50
BD-26 Spot 20	1019	402.55	4.81
BD-26 Spot 13	416	403.09	3.85
BD-26 Spot 50	568	403.23	3.74
BD-26 Spot 74	638	403.24	3.20
BD-26 Spot 14	397	403.30	4.41
BD-26 Spot 93	488	403.62	3.88
BD-26 Spot 47	222	405.01	3.73
BD-26 Spot 31	429	405.04	4.43
BD-26 Spot 40	737	405.72	5.35

BD-26 Spot 101	320	406.18	4.39
BD-26 Spot 43	285	406.19	4.50
BD-26 Spot 75	444	406.75	4.72
BD-26 Spot 29	689	408.55	5.13
BD-26 Spot 22	345	408.93	5.74
BD-26 Spot 2	638	409.15	4.63
BD-26 Spot 25	897	410.10	5.03 manually removed; discordant
BD-26 Spot 46	305	411.61	2.90
BD-26 Spot 38	382	418.33	4.25
BD-26 Spot 77	459	418.61	4.51
BD-26 Spot 94	378	457.44	6.00
BD-26 Spot 106	1003	460.10	4.56
BD-26 Spot 10	1198	463.48	4.88
BD-26 Spot 92	814	463.67	5.10
BD-26 Spot 6	3176	464.08	4.42
BD-26 Spot 109	197	465.93	4.80
BD-26 Spot 65	392	467.09	4.82
BD-26 Spot 62	895	467.73	4.74
BD-26 Spot 23	542	469.21	4.63
BD-26 Spot 34	123	469.72	4.08
BD-26 Spot 45	515	470.07	5.60
BD-26 Spot 79	758	473.10	4.94
BD-26 Spot 19	317	474.40	4.44
BD-26 Spot 86	580	480.07	5.92
BD-26 Spot 18	1653	483.82	4.78
BD-26 Spot 98	425	487.34	5.31 manually removed; discordant
BD-26 Spot 100	505	488.34	4.87
BD-26 Spot 91	126	526.25	6.08
BD-26 Spot 54	155	541.28	4.84
BD-26 Spot 68	1050	542.94	5.57
BD-26 Spot 78	922	548.89	6.06
BD-26 Spot 71	343	549.80	5.16
BD-26 Spot 4	668	556.84	5.89
BD-26 Spot 1	438	566.44	6.04
BD-26 Spot 12	1286	581.14	17.15
BD-26 Spot 73	225	613.69	6.97
BD-26 Spot 8	346	631.46	5.71
BD-26 Spot 37	370	632.00	6.43
BD-26 Spot 61	658	645.80	6.49
BD-26 Spot 15	440	653.30	6.94
BD-26 Spot 64	139	699.65	6.54
BD-26 Spot 97	549	777.01	9.05
BD-26 Spot 103	406	800.48	10.43
BD-26 Spot 49	473	941.02	13.36
BD-26 Spot 7	275	979.69	22.69

BD-26 Spot 99	401	996.63	12.29
BD-26 Spot 67	258	1000.30	14.95
BD-26 Spot 56	519	1004.55	10.54
BD-26 Spot 9	102	1005.40	14.78
BD-26 Spot 52	847	1027.07	11.15
BD-26 Spot 83	453	1037.36	12.83
BD-26 Spot 102	138	1037.87	14.89
BD-26 Spot 36	31	1039.93	19.57
BD-26 Spot 26	1024	1040.03	11.72
BD-26 Spot 11	321	1040.23	13.61
BD-26 Spot 66	234	1040.79	14.84
BD-26 Spot 58	61	1049.41	15.64
BD-26 Spot 95	260	1054.85	13.43
BD-26 Spot 48	156	1061.91	16.69
BD-26 Spot 81	135	1063.88	16.77
BD-26 Spot 51	194	1064.21	15.57
BD-26 Spot 55	140	1072.37	14.62
BD-26 Spot 105	47	1080.02	16.48
BD-26 Spot 85	342	1228.77	13.42
BD-26 Spot 24	159	1246.76	13.60
BD-26 Spot 28	460	1440.89	12.54
BD-26 Spot 27	417	2128.91	8.83
BD-26 Spot 63	134	2655.94	9.54

**Sample BD-35**

-BD-35 Basin Spot	532	0.39	0.02
-BD-35 Basin Spot	202	0.46	0.02
-BD-35 Basin Spot	104	0.82	0.05
-BD-35 Basin Spot	110	0.84	0.04
-BD-35 Basin Spot	189	1.03	0.04
-BD-35 Basin Spot	72	1.15	0.06
-BD-35 Basin Spot	159	1.17	0.05
-BD-35 Basin Spot	105	1.44	0.06
-BD-35 Basin Spot	223	1.57	0.06
-BD-35 Basin Spot	244	1.69	0.05
-BD-35 Basin Spot	847	2.51	0.04
-BD-35 Basin Spot	345	3.25	0.16
-BD-35 Basin Spot	101	5.06	0.13
-BD-35 Basin Spot	56	5.88	0.16
-BD-35 Basin Spot	408	9.36	0.13
-BD-35 Basin Spot	266	10.07	0.16
-BD-35 Basin Spot	3875	15.26	0.16
-BD-35 Basin Spot	205	15.56	0.22
-BD-35 Basin Spot	98	19.58	0.33

-BD-35 Basin Spot	15	23.89	0.69
-BD-35 Basin Spot	49	25.52	0.51
-BD-35 Basin Spot	275	65.90	0.72
-BD-35 Basin Spot	49	88.04	0.83
-BD-35 Basin Spot	641	141.04	1.50
-BD-35 Basin Spot	211	160.16	2.06
-BD-35 Basin Spot	143	188.03	1.93
-BD-35 Basin Spot	51	192.99	2.10
-BD-35 Basin Spot	78	196.38	2.41
-BD-35 Basin Spot	791	238.05	10.33 manually rejected; discordant
-BD-35 Basin Spot	242	239.70	3.13
-BD-35 Basin Spot	92	240.26	2.48
-BD-35 Basin Spot	221	242.47	2.78
-BD-35 Basin Spot	240	243.26	3.04
-BD-35 Basin Spot	297	245.11	2.17
-BD-35 Basin Spot	70	245.44	2.69
-BD-35 Basin Spot	348	245.72	2.26
-BD-35 Basin Spot	160	247.37	2.74
-BD-35 Basin Spot	44	249.14	2.17 manually rejected; discordant
-BD-35 Basin Spot	165	249.53	7.55
-BD-35 Basin Spot	757	254.02	3.78
-BD-35 Basin Spot	1228	254.93	3.05
-BD-35 Basin Spot	217	260.46	3.11
-BD-35 Basin Spot	31	262.57	2.71
-BD-35 Basin Spot	145	262.76	1.97
-BD-35 Basin Spot	259	262.80	3.24
-BD-35 Basin Spot	969	263.28	2.79
-BD-35 Basin Spot	99	269.37	2.78
-BD-35 Basin Spot	203	269.64	3.61
-BD-35 Basin Spot	575	270.07	3.32
-BD-35 Basin Spot	46	273.11	2.57
-BD-35 Basin Spot	226	277.25	3.53
-BD-35 Basin Spot	181	279.46	2.73
-BD-35 Basin Spot	425	286.86	3.36
-BD-35 Basin Spot	733	349.16	4.08
-BD-35 Basin Spot	761	357.44	5.79 manually rejected; discordant
-BD-35 Basin Spot	999	382.06	4.56
-BD-35 Basin Spot	84	382.36	4.05
-BD-35 Basin Spot	160	386.64	4.17
-BD-35 Basin Spot	151	387.67	4.12
-BD-35 Basin Spot	413	387.70	4.38
-BD-35 Basin Spot	414	395.50	4.70
-BD-35 Basin Spot	300	399.18	4.49
-BD-35 Basin Spot	52	399.44	3.83
-BD-35 Basin Spot	46	403.02	3.88



-BD-35 Basin Spot	426	406.70	4.56	
-BD-35 Basin Spot	136	424.88	16.05	
-BD-35 Basin Spot	516	461.67	5.02	manually rejected; discordant
-BD-35 Basin Spot	257	465.44	5.95	
-BD-35 Basin Spot	233	478.50	5.45	
-BD-35 Basin Spot	832	505.79	5.27	
-BD-35 Basin Spot	93	554.84	6.32	
-BD-35 Basin Spot	306	557.32	6.36	
-BD-35 Basin Spot	405	661.46	8.94	
-BD-35 Basin Spot	99	692.02	5.25	
-BD-35 Basin Spot	219	847.45	9.81	
-BD-35 Basin Spot	450	878.14	11.49	
-BD-35 Basin Spot	105	959.55	15.41	
-BD-35 Basin Spot	550	998.36	13.52	
-BD-35 Basin Spot	67	1014.49	16.35	
-BD-35 Basin Spot	70	1030.12	15.20	
-BD-35 Basin Spot	26	1045.23	14.94	
-BD-35 Basin Spot	200	1051.70	18.87	
-BD-35 Basin Spot	271	1067.07	12.70	
-BD-35 Basin Spot	35	1090.04	22.31	
-BD-35 Basin Spot	104	1102.74	13.24	
-BD-35 Basin Spot	16	1118.09	22.89	
-BD-35 Basin Spot	59	1123.84	17.69	
-BD-35 Basin Spot	217	1129.31	13.47	
-BD-35 Basin Spot	167	1143.29	15.16	
-BD-35 Basin Spot	229	1192.99	18.82	
-BD-35 Basin Spot	280	1215.45	14.30	
-BD-35 Basin Spot	172	1240.17	13.77	
-BD-35 Basin Spot	410	1249.87	16.17	
-BD-35 Basin Spot	200	1369.32	14.37	
-BD-35 Basin Spot	227	1416.73	14.81	
-BD-35 Basin Spot	38	1451.60	14.19	
-BD-35 Basin Spot	170	1636.69	15.07	
-BD-35 Basin Spot	108	1851.41	13.41	
-BD-35 Basin Spot	81	1967.02	11.32	
-BD-35 Basin Spot	373	2078.25	11.85	
-BD-35 Basin Spot	92	2658.39	10.79	
-BD-35 Basin Spot	96	2767.27	11.78	
-BD-35 Basin Spot	202	3849.58	NA	manually rejected; discordant

**Sample BD-36**

BD-36 Spot 4	572	0.24	0.01	discordant; manually rejected
BD-36 Spot 27	662	0.76	0.02	"OK" manually
BD-36 Spot 9	223	1.30	0.05	

BD-36 Spot 23	634	1.31	0.03
BD-36 Spot 51	73	1.65	0.08
BD-36 Spot 30	294	1.92	0.05
BD-36 Spot 31	177	3.39	0.07 "OK" manually
BD-36 Spot 20	52	4.22	0.19 "OK" manually
BD-36 Spot 3	207	11.70	0.15
BD-36 Spot 49	390	11.93	0.17
BD-36 Spot 48	109	12.07	0.21
BD-36 Spot 54	236	14.91	0.18
BD-36 Spot 67	72	17.65	0.37
BD-36 Spot 22	1214	26.04	0.52
BD-36 Spot 59	607	38.55	0.52
BD-36 Spot 33	184	100.21	0.97
BD-36 Spot 98	832	125.88	1.29
BD-36 Spot 62	133	157.81	1.70
BD-36 Spot 42	304	182.85	2.18
BD-36 Spot 65	268	232.40	2.84
BD-36 Spot 25	310	240.84	2.97 discordant; manually rejected
BD-36 Spot 35	358	242.70	2.44
BD-36 Spot 28	883	243.15	2.17
BD-36 Spot 100	137	243.74	2.27
BD-36 Spot 32	294	243.89	3.19
BD-36 Spot 57	709	246.04	2.76
BD-36 Spot 76	409	246.32	2.25
BD-36 Spot 19	192	246.83	2.38 discordant; manually rejected
BD-36 Spot 82	54	249.83	2.58 discordant; manually rejected
BD-36 Spot 73	225	250.89	2.93
BD-36 Spot 14	78	251.00	3.26
BD-36 Spot 34	195	251.27	2.26
BD-36 Spot 74	555	255.42	3.28 discordant; manually rejected
BD-36 Spot 17	118	258.17	2.12
BD-36 Spot 104	251	264.12	2.33
BD-36 Spot 90	229	264.14	3.22
BD-36 Spot 107	145	265.05	3.22
BD-36 Spot 86	206	265.67	2.65
BD-36 Spot 61	204	265.74	3.06
BD-36 Spot 7	280	277.27	3.40
BD-36 Spot 0	544	280.29	2.65
BD-36 Spot 99	237	286.48	3.62
BD-36 Spot 40	216	289.82	2.74
BD-36 Spot 81	48	309.08	3.94
BD-36 Spot 87	675	335.25	3.71
BD-36 Spot 45	324	339.39	3.81
BD-36 Spot 53	370	356.98	4.24
BD-36 Spot 85	329	363.84	3.85

BD-36 Spot 101	292	365.64	3.97
BD-36 Spot 55	88	367.55	2.84
BD-36 Spot 64	292	368.34	4.29
BD-36 Spot 43	369	369.51	4.02
BD-36 Spot 13	529	377.05	3.69
BD-36 Spot 78	206	379.10	4.69
BD-36 Spot 50	119	379.21	3.14
BD-36 Spot 102	311	381.35	4.04
BD-36 Spot 58	178	383.64	3.68
BD-36 Spot 41	240	384.10	3.28
BD-36 Spot 66	147	388.19	3.52
BD-36 Spot 106	593	389.54	3.91
BD-36 Spot 95	435	393.73	4.27
BD-36 Spot 89	303	395.22	4.38
BD-36 Spot 88	87	400.96	4.30
BD-36 Spot 36	209	471.67	4.53
BD-36 Spot 109	113	473.11	5.15
BD-36 Spot 11	446	489.15	4.48
BD-36 Spot 68	409	494.17	3.71
BD-36 Spot 63	82	535.34	4.81
BD-36 Spot 24	135	549.51	5.00
BD-36 Spot 69	409	560.50	5.92
BD-36 Spot 70	381	566.33	6.29
BD-36 Spot 12	604	587.35	4.30
BD-36 Spot 77	680	590.43	4.74
BD-36 Spot 93	340	592.93	6.42
BD-36 Spot 75	275	616.83	7.17
BD-36 Spot 47	101	637.36	4.83
BD-36 Spot 5	135	638.55	5.73
BD-36 Spot 56	54	766.43	6.19
BD-36 Spot 39	475	784.69	10.63
BD-36 Spot 108	32	840.95	9.27
BD-36 Spot 29	242	909.20	10.87
BD-36 Spot 60	133	974.23	15.90
BD-36 Spot 92	221	1002.13	13.89
BD-36 Spot 105	701	1002.17	11.59
BD-36 Spot 15	336	1018.42	11.50
BD-36 Spot 21	132	1021.59	13.52
BD-36 Spot 52	457	1043.91	13.84
BD-36 Spot 79	177	1045.49	13.51
BD-36 Spot 103	320	1048.12	12.44
BD-36 Spot 71	166	1068.54	14.03
BD-36 Spot 46	307	1069.06	12.34
BD-36 Spot 80	228	1071.08	13.05
BD-36 Spot 94	113	1082.63	13.52

BD-36 Spot 6	147	1084.53	14.83	
BD-36 Spot 84	199	1085.88	11.30	
BD-36 Spot 26	179	1101.27	15.35	
BD-36 Spot 8	159	1178.96	12.03	
BD-36 Spot 37	28	1216.47	17.75	
BD-36 Spot 10	372	1237.51	13.76	
BD-36 Spot 1	290	1246.15	13.83	
BD-36 Spot 44	1237	1263.55	22.80	discordant; manually rejected
BD-36 Spot 18	244	1344.87	12.14	
BD-36 Spot 96	259	1362.94	11.45	
BD-36 Spot 2	90	1420.77	10.97	
BD-36 Spot 97	183	1453.85	12.16	

Table S2 Statistical tests of paired samples of U-Pb data from detrital zircons at Salinas del Bebedero

	cross correlation	likeness	Similarity	Kolmogorov-Smirnoff test		Kuiper test	
				<i>p value</i>	<i>k value</i>	<i>p value</i>	<i>v statistic</i>
<b>BD-26 vs BD-35</b>	0.19	0.306	0.533	0	0.511	0	0.651
Probability Density Function	0.08	0.298	0.569	0	0.511	0	0.651
Kernal Density Estimate							
<b>BD-35 vs BD-36</b>							
Probability Density Function	0.99	0.991	0.979	0	0.02	0	0.03
Kernal Density Estimate	0.783	0.69	0.879	0.147	0.156	0.028	0.254
<b>BD-26 vs BD-36</b>							
Probability Density Function	0.03	0.401	0.596	0	0.462	0	0.458
Kernal Density Estimate	0.132	0.39	0.649	0	0.462	0	0.548

Table S3 Input characteristics of the model runs. See Figure S4 for the associated input hydrographs.

#	Flood Source (location)	Total Flow Volume (10 <sup>6</sup> m <sup>3</sup> )	Flood duration (days)	Simulation duration (days)	Peak discharge (m <sup>3</sup> s <sup>-1</sup> )	Outflow location	Outflow slope (m/m)	Manning n	Input DEM	Computational Cell size (m)	Computational Time Step (minutes)	Over-topped ?
1	Rio Mendoza (32.94S, 68.49W)	180	2.5	30	2,000	10 km downstream to the divide (34.13S, 66.75W)	0.01	0.03	SRTM 1 Arc-second	100	1	No
2		3,000	2.5	30	10,000							No
3	Rio Tunuyán (33.21S, 68.64W)	400	3	30	3,000							Yes
4		8,000	7	20	10,000							Yes