



*Supplement of*

**Saline groundwater evolution in the Luanhe River delta (China) during the Holocene: hydrochemical, isotopic, and sedimentary evidence**

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Table S1 Hydrochemical and stable isotopic data from water samples in study area.

Water	Position	Site	Label	Depth(m)	$\rho$ (mg/L)								TDS (g/L)	pH	$\delta$ D(‰, VSMOW)	$\delta$ <sup>18</sup> O(‰, VSMOW)	Uncertainty ‰	
					K <sup>+</sup>	Na <sup>+</sup>	Ca <sup>2+</sup>	Mg <sup>2+</sup>	Cl <sup>-</sup>	SO <sub>4</sub> <sup>2-</sup>	HCO <sub>3</sub> <sup>-</sup>	Br <sup>-</sup>					$\delta$ D	$\delta$ <sup>18</sup> O
<b>Shallow groundwater:</b>																		
Old delta		G01	G01-10	10.00	21.22	14.11	43.34	17.65	19.52	21.48	246.18	0.384	7.60	-58.9	-8.2	±0.39	±0.04	
		G02	G02-10	10.00	2.39	73.33	127.27	55.26	79.74	184.82	451.77	0.975	7.32	-44.1	-8.0	±1	±0.2	
Fresh	Alluvial fan	P01	P01-15	15.00	3.01	64.53	171.10	67.88	173.94	133.59	410.34	1.159	8.42					
		P07	P07-20	20.00	0.973	32.2	144	18.2	64.5	116	199	0.074	0.575	7.78	-57.1	-7.5	±1	±0.2
		P08	P08-30	30.00	1.142	13.3	53.7	16.1	14.0	23.5	151	0.037	0.384	8.20	-58.8	-7.9	±1	±0.2
		G06	G06-15	10.00	5.17	209	110	66.4	391	204	338	1.06	1.324	7.59	-59.1	-8.2	±0.37	±0.08
		G08	G08-15	10.00	35.6	666	136	127	1087	415	374	4.38	2.841	7.84	-52.6	-7.3	±0.24	±0.09
		G07	G07-15	15.00	9.70	582.73	229.08	110.97	953.31	457.90	448.50		2.792	7.62	-54.2	-6.5	±0.14	±0.09
Brackish	New delta	P02	P02-20	20.00	1.99	153.60	164.13	79.93	232.34	226.83	509.28		1.606	8.51				
		P05	P05-20	20.00	56.12	310.82	207.78	112.98	397.58	394.48	686.07		2.584	8.39				
		P14	P14-15	15.00	37.60	811.00	143.00	137.00	1357.00	428.00	398.00	3.94	3.312	7.89	-52.9	-7.5	±1	±0.2
		P06	P06-20	20.00	19.03	532.42	41.36	26.15	435.29	142.11	593.62		1.987	8.34				
		G03	G03-5	5.00	162.80	4558.4	336.08	698.13	7949.85	1388.5	1476.45		16.57	6.98	-39.8	-6.7	±1	±0.2
		G04	G04-15	15.00	194.47	13502.	559.29	1725.67	25215.25	3565.6	1034.50		45.797	7.25	-51.2	-6.5	±0.54	±0.07
	Old delta	G05	G05-10	10.00	200.73	5167.9	337.58	640.08	9113.11	2208.2	432.13		18.099	7.45	-29.8	-4.9	±1	±0.2
		G05	G05-20	20.00	185	5414	291	673	9223	1803	646	38.7	18.235	7.41				
		G05	G05-46	46.00	229.51	6743.2	278.53	824.20	12432.88	1700.9	995.21		23.205	7.44	-25.6	-4.1	±1	±0.2
		G07	G07-27	27.00	27.11	2043.8	305.71	198.94	3650.06	570.62	350.29		7.147	7.32	-64.6	-8.7	±1	±0.2
		G08	G08-40	40.00	66.31	7371.3	1217.2	1028.62	15073.12	2039.9	376.48		27.173	6.95	-46.2	-5.4	±0.26	±0.07
		Saline	G09	G09-15	15.00	27.07	1121.8	236.66	172.54	1885.99	406.47	576.18		4.426	7.2	-45.3	-5.7	±0.55
G09	G09-40			40.00	184.61	11882.	539.23	1557.19	22669.53	2900.7	608.91		40.342	6.77	-39.4	-5.2	±0.45	±0.08
	New delta	G10	G10-10	10.00	294.60	9221.2	354.32	1181.33	16220.80	2683.1	674.39		30.629	7.11	-31.4	-4.0	±0.56	±0.05
		P03	P03-20	20.00	16.09	285.29	432.17	202.41	682.71	1139.6	314.65		3.258	7.24				
		P04	P04-30	30.00	50.98	1103.4	133.29	135.89	1775.19	258.68	548.21		5.056	8.38				
		P09	P09-30	30.00	314	12267	408	1469	21909	2730	543	88.8	39.64	7.19	-37.7	-4.9	±1	±0.2
		P10	P10-30	30.00	159	13833	744	2153	26270	3725	586	114	47.47	6.93	-27.7	-3.9	±1	±0.2
		P11	P11-20	20.00	280	15377	707	2147	29689	3542	404	119	52.146	6.90	-26.3	-2.7	±1	±0.2
		G03	G03-20	20.00	545.21	25182.	948.30	3245.41	45835.43	4308.9	622.01		80.688	6.65	-27.8	-3.2	±0.22	±0.14
			G03	G03-30	30.00	489	23365	776	3073	42871	4383	525	198	75.48	6.93			
Brine	Old delta	G04	G04-40	40.00	159.98	23056.	1253.7	3507.54	48229.65	4450.4	667.84		81.325	6.7	-43.1	-6.4	±1	±0.2
		P12	P12-40	40.00	836	39463	759	4695	70961	8518	489	254	125.975	6.68	-36.5	-4.7	±1	±0.2
	New delta	G10	G10-30	30.00	449.23	15416.	437.65	1996.27	29889.91	3358.7	933.01	97.4	52.482	6.98	-22.5	-2.1	±0.22	±0.07
<b>Deep groundwater:</b>																		
Brackish	Old delta	P13	P13-200	200.00	1.34	452	40.2	31.5	417	120	555	2.01	1.617	7.66	-70.0	-9.1	±1	±0.2
		Alluvial fan	P07	P07-100	100.00	1.143	19.8	45.2	12.8	12.1	13.4	163	0.036	0.267	8.29	-57.1	-7.6	±1
Fresh	New delta	P14	P14-300	300.00	0.388	104.0	17.1	3.38	29.0	20.4	205	0.10	0.379	8.14	-71.3	-9.8	±1	±0.2
		P15	P15-150	150.00	0.540	116	14.5	3.40	35.0	45.2	266	0.14	0.481	7.65	-70.4	-9.0	±1	±0.2
	Old delta	P17	P17-200	200.00	0.286	144	6.29	1.61	24.5	72.0	241	0.089	0.489	8.48	-75.5	-8.6	±1	±0.2
		P16	P16-100	100.00	0.355	42.6	41.8	12.5	5.29	28.4	235	0.021	0.365	8.13	-67.8	-9.0	±1	±0.2
<b>Surface water:</b>																		
Fresh	New delta	LH01	LH01		6.16	27.25	68.93	25.67	35.41	123.53	199.70		0.492	7.95	-53.5	-8.4	±1	±0.2
		LH02	LH02		6.28	27.96	68.65	26.05	36.84	124.71	199.70		0.495	8.04	-52.5	-7.3	±1	±0.2
	Old delta	SH01	SH01		6.54	89.27	33.93	20.67	71.18	123.17	111.31		0.479	8.72	-54.2	-7.4	±1	±0.2
		SH02	SH02		12.84	108.98	126.31	52.02	98.14	298.01	396.12		1.095	7.55	-51.0	-6.9	±1	±0.2
Seawater	Sea	Bohai	SW01		346.43	9025.9	338.80	1077.72	16977.15	2578.3	140.77	58.73	30.485	7.91	-8.4	-3.4	±1	±0.2
Rain	Rain	Rain	R1											-36.2	-6.7	±1	±0.2	
Brine	Evaporation	P18	P18		7530	73447	184	28197	174567	35794	634	558	320.353	6.68	-19.3	-0.6	±1	±0.2

Table S2 <sup>14</sup>C measured value and corrected ages of groundwater samples in the Luanhe River Delta.

Site	Label	<sup>14</sup> C(pmC)	Uncorrected Radiocarbon Age(a B.P.)	δ <sup>13</sup> C (‰, VPDB)	Corrected model	q	Corrected Age(a B.P.)
<b>G01</b>	G01-10	105.9±0.40	Modern	-12.6		0.85	Modern
<b>G03</b>	G03-20	49.9±0.2	5590	-12.6		0.85	4323
<b>G04</b>	G04-15	72±0.3	2640	-14.7		0.982	2495
<b>G05</b>	G05-30	66.8±0.2	3240	-11.8		0.81	1512
<b>G06</b>	G06-15	100.2±0.4	Modern	-8.2		0.59	Modern
<b>G07</b>	G07-15	74.3±0.3	2390	-10.2	δ <sup>13</sup> C model	0.71	Modern
<b>G08</b>	G08-15	97.30±0.4	220	-9.2		0.65	Modern
	G08-40	30.6±0.1	9510	-10.4		0.72	6884
<b>G09</b>	G09-15	99.5±0.4	40	-11.5		0.79	Modern
<b>G09</b>	G09-40	57.8±0.2	4410	-11.3		0.78	2367
<b>G10</b>	G10-10	91.4±0.3	720	-14.3		0.96	376
	G10-30	85.6±0.3	1250	-15		1	1245
<b>P14</b>	P14-300	0.774±0.08	39050			0.83	37486
<b>P15</b>	P15-150	1.21±0.09	35460		CMB model	0.83	33951
<b>P16</b>	P16-100	11.33±0.1	17490			0.82	15959