Table S1. Hydrogeochemical results including stable isotopes.

№ on map	Name/Country	Latitude (°N)	Longitude (°E)	Altitude m. ASL	TDS g/L	T °C	pH	Eh mV	Na^+	Ca^{2+}	Mg^{2+}	K^+	Cl^-	SO_4^{2-}	HCO_3^-	Si	F	Li	Fe	Al	Br	B	$\delta^{18}O$	δD	$\delta^{13}C_{HCO3}$
									mg/L														%VSMOW		‰VPDB
Ca-HCO_3 (Ca-Mg-HCO_3. Na-Ca-HCO_3) temporary hardness groundwater																									
7	Kokpek. KZ	43.46667	78.68289	1230	0.4	17	7.9	115	48	45	13	1.2	10	71	213	5	0.4	0.02	0.06	0.00	0.05	0.07	−15	−109	
19	Ak-Su Belorechka. KG	42.463507	74.097397	2471	1.0	14	7.5	10	38	112	77	1.6	3	91	600	17	0.3	0.03	4.1	0.02	0.01	0.2	−12.8	−86	−7.4
21	Kara-Keche. KG	41.737968	74.78273	2994	2.5	5	6.5	83	25	466	123	6.4	4	675	1220	7	0.3	0.04	0.05	0.02	0.01	0.07	−11.1	−78	7
23	Kol'su. KG	40.76057	76.29947	3361	3.3	7	6.8	100	266	355	224	8.3	439	455	1586	26	0.3	0.2	1.7	0.01	0.4	0.3	−12.4	−87	8.1
24	Chatirkul. KG	40.569532	75.351823	3527	3.2	5	6.8	7	201	344	239	4.8	236	37	2119	54	0.3	0.6	32	0.04	0.5	0.4	−11.6	−78	8.8
43	Sist. TJ	37.17661	71.44827	2300	0.9	11	5.9	98	23	137	46	4	21	231	383	22	-	0.07	12	0.06	-	0.15	−14.1	−102	
44	AVDJ. TJ	36.92725	71.49244	2427	1.9	35	6.2	129	116	287	60	28	156	286	894	24	0.1	0.9	0.7	0.04	0.22	2.4	−14.1	−103	
45	AVDJ (down). TJ	36.95586	71.47086	2431	1.7	31	6.4	135	183	237	47	27.4	213	234	820	36	0.1	1.2	0.3	0.03	0.49	0.8	−14.8	−106	
46	Barshor. TJ	37.00139	71.46967	2390	2.8	15	6.1	95	338	327	77	33	433	178	1342	34	-	2.1	7.2	0.1	0.78	1.4	−14.4	−104	5.7
51	Firguza-MGU [1]	-	-	-	1.1	14	6.7	-	112	160	19	5	114	55	639	-	-	0.2	-	-	0.05	1.1	-	-	
54-1	Tashkorgan [2] CH	-	-	3050	0.5	27	7.2	-	96	61	15	10.9	63	100	314	56	3.5	-	-	-	-	-	−13.0	−93.9	
Na-HCO_3 (Na-Cl-HCO_3) alkali carbonate groundwater																									

11	Kerimagash. KZ	43.98113	79.8213	493	0.5	49	8.4	48	144	0.6	0.01	1.7	39	77	160	36	2.9	0.02	0.02	0.2	0.04	0.3	−12.5	-	−14
17	Merke. KZ	42.74441	73.2258	1148	0.3	20	9.3	−158	77	2.5	0.2	0.5	10	34	156	9	13.5	0.07	0.09	0.05	0.08	0.1	−10.2	−73	−14
22	Beshbelchir. KG	41.115848	76.509596	3298	2.5	16	7.4	73	423	240	50	35	234	125	1380	16	0.3	0.2	0.2	0.2	0.3	3.3	−15.3	−109	7.9
25	Narzan. KG	40.455535	74.682018	2008	7.2	7	7.8	0	2186	73	83	35	1408	15	3468	16	0.3	1.8	3.6	0.09	0.6	7.4	−11.1	−104	4.4
47	Garm-Chashma. TJ	37.20367	71.53717	2566	3.3	60	6.7	−281	652	158	33	77	404	200	1542	66	-	1.9	0.04	0.02	0.98	8.2	−14.7	−109	3.6
54-2	Tashkorgan [2] CH	-	-	3050	2.7	91	8.4	-	852	13	14	117	425	632	781	92	7.9	-	-	-	-	-	−10.8	−80.8	
Na-Cl (Na-Cl-HCO_3) and Na-SO_4 saline groundwaters																									
1	Alma-Arasan. KZ	43.08393	76.90701	1855	0.2	35	7.1	30	55	2.4	0.1	0.9	20	42	70	25	7	0.02	0	0.008	0.02	0.05	−12.8	−80	
2	Nizne-Kamenka. KZ	43.22943	76.79607	781	2.8	51	9.7	−208	1448	984	5.8	16	3740	178	2	14	3.1	0.2	0	0.04	15.3	1.04	−12.4	−87	
3	Kazachka. KZ	43.12548	76.92771	1441	0.4	16	7.5	−127	41	10	4	0.9	31	4.5	110	5	2.1	0.02	0	0.004	0.03	0.05	−12	−80	
5	Tauturgen. KZ	43.27656	77.70142	1389	1.3	29	7.9	−159	304	94	2	3.5	103	725	49	9	4.2	0.5	0.08	0.04	0.3	0.7	−12.6	−89	
6	Kuram. KZ	43.48795	78.16935	811	1.2	19	7.1	64	342	110	7	3.2	344	406	10	8.4	2.3	0.8	0.1	0.01	1.2	1.9	−13.2	−95	
9	Chunzha. KZ	43.64474	80.10007	663	0.9	42	8.2	132	281	16	2	4	172	146	219	11	5.5	0.05	0	0.03	0.7	1.3	−13.8	−97	
10	Zharkent-Arasan. KZ	44.33234	79.78934	1041	1.0	40	8.0	73	276	34	0.9	8	146	378	61	24	7.6	0.5	0	0.01	0.24	1	−12	−89	−4.1
12	Kalkan. KZ	43.92288	78.79414	522	4.9	33	7.9	−110	1521	93	9.6	11	1193	1912	134	13	6.3	0.15	0.1	0.04	0.1	0.8	−14.4	−104	−8.4
13	Kopal-Arasan. KZ	45.28655	79.35574	933	0.6	40	9.1	−148	152	11.6	0.05	3	102	169	25	5	10	0.3	0	0.02	0.09	1.5	−13.2	−94	−17.7
15	Chushkala. KZ	43.85359	76.99836	501	5.3	10	8.9	15	1365	294	64	9	1091	2413	27	10	0.1	0.2	0.02	0.03	1.9	1.9	-	−112	

Table S1. (Continuation).

№ on map	Name/Country	Latitude (°N)	Longitude (°E)	Altitude m. ASL	TDS g/L	T °C	pH	Eh mV	Na^+	Ca^{2+}	Mg^{2+}	K^+	Cl^-	SO_4	HCO_3^-	Si	F	Li	Fe	Al	Br	B	^{18}O	D	$\delta^{13}C_{HCO3}$
									mg/l														%VSMOW		‰VPDB
Na-Cl (Na-Cl-HCO_3) and Na-SO_4 saline groundwaters																									
16	Keskelen. KZ	43.03728	76.61027	1686	0.4	24	10.3	−150	136	0.88	0.03	0.9	75	91	7	19	23.6	0.2	0.06	0.03	0.08	0.3	−13.2	−88	
18	Alamedin. KG	42.61411	74.66366	1700	0.4	46	8.4	−40	92	21	0.64	1.5	24	161	12	16	9.5	0.09	0.08	0.06	0.09	0.3	−12	−84	−11
20	Dostik. KG	41.363875	75.574177	1811	0.7	17	7.8	70	102	70	24	3	127	173	170	8	0.3	0.02	0.2	0.2	0.07	0.3	−12.7	−90	−6.3
26	Kara-Shoro. KG	40.753898	74.061887	2227	4.6	12.1	6.3	13	1552	187	61	40	1931	2	976	11	0.3	2.5	10	0.07	0.7	2.3	−14.1	−98	10.7
27	Kara-Shoro top. KG	40.761356	74.117429	2367	6.9	12.5	8.0	64	2143	209	86	13	3179	0.1	1320	10	0.3	1.7	5	0.02	0.7	1.3	−12.8	−93	7
28	Shor-Bulak. KG	40.759828	74.056551	2223	1.9	13	7.1	60	617	50	21	24	672	1.2	561	8	0.3	1	1.8	0.05	0.3	1.3	−14.7	−98	
29	Karabulak. KG	40.760386	74.056383	2213	6.5	13.2	6.5	93	1995	228	62	54	3397	4.2	732	7	0.3	2.8	4.6	0.07	1.0	2.1	−14	−94	
Na-Cl (Na-Cl-HCO_3) and Na-SO_4 saline groundwaters																									
30	Kari-Oi. KG	42.617439	77.005293	1616	2.2	16.7	7.1	−110	801	37	1.35	5	1208	42	81	19	0.3	0.04	0.1	0.08	1.7	5.5	−15.7	−78	−17
31	Keremetsu. KG	42.726857	77.831504	1617	7.1	40.5	7.9	60	1702	941	1.8	12	4341	86	10	10	0.3	0.04	0	0.05	3.8	1.6	−12.6	−90	−15.4
32	Ak-Su. KG	42.452724	78.55408	1967	0.5	42.9	9.2	−82	116	13	0.06	1.9	83	92	37	46	12.5	0.16	0.02	0.03	0.12	0.26	−13.7	−95	−13
33	Altyn-Arashan Frog. KG	42.37864	78.59833	2455	0.4	31	9.7	−148	98	9	0.3	3	65	48	70	28	16	0.23	0.1	0.08	0.1	0.5	−12.7	−89	
34	Altyn-Arashan top. KG	42.37189	78.611906	2507	0.3	40	8.1	98	58	19	2	3	37	31	91	19	9.4	0.1	0	0.01	0.07	0.3	−12.4	−88	
36	Djety-Oguz top. KG	42.322525	78.247451	2178	0.6	20.7	8.5	65	141	56	0.4	3	178	141	50	16	6.1	0.25	0.1	0.00	0.1	0.7	−13.6	−96	
37	Djety-Oguz 1bh. KG	42.326436	78.245158	2062	13	40.6	7.3	−110	2669	2004	3.3	57	7594	553	65	33	0.3	5	0.4	0.1	3.1	9	−14	−82	−15.8

38	Djety-Oguz 6bh. KG	42.327216	78.244002	2057	10	37	7.5	−166	2022	1517	1.6	42	5836	594	10	19	0.3	3.8	0.2	0.08	2.2	7.19	−12.3	−83	−11.9
39	Djily-Su. KG	42.221708	78.167686	2334	0.4	37.4	9.4	−260	110	16	0.2	3.6	111	77	21.8	28	10.5	0.2	0.01	0.02	0.1	0.7	−12	−80	−16.6
40	Jiluu-Su. KG	42.404231	77.882946	1619	0.3	38.3	9.2	−41	106	5	0.11	1	51	62	67	13	12	0.004	0.02	0.05	0.05	0.43	−11.7	−75	
41	Djuku-Chak. KG	42.181874	78.007523	2148	0.4	38	8.8	−187	79	16	0.35	1.5	47	88	61	18	11	0.07	0.01	0.01	0.05	0.24	−11.9	−82	
42	Kadjisai. KG	42.165168	77.171591	1643	2.4	50	8.8	25	772	13	0.53	7	528	535	429	16	18	0.12	0.08	0.03	0.3	3.9	−9.3	−80	−5.8
48	Djelandy. TJ	37.57209	72.58162	3573	0.4	79	7.8	−69	77	1.4	0.01	1.7	14	71	70	43	8.1	0.08	0.01	0.04	0.02	0.3	−17.8	−130	−7.6
49	Khoja-Obi-Garm. TJ	38.8949	68.78749	1806	0.4	94	8.9	−350	101	3.5	0.03	7	50	107	67	57	18	0.8	0.03	0.09	0.1	0.3	−13.3	−85	−6.2
50	Faizanbod. TJ	38.52699	69.21024	1100	2.0	31	8.3	196	634	7.9	3.1	3	85	925	403	7	-	0.3	0.04	0.02	0.29	1.1	−13.1	−88	
52	Tamdikul. TJ [1]	-	-	-	0.8	88	7.8	-	227	1.6	1.9	5	71	235	214	12	-	0.2	-	-	1.6	-	-	-	
53	*Obigarm. TJ [1]	-	-	-	0.7	52	7.2	-	220	13	4	3	140	299	32	67	-	0.2	0.03	-	0.3	-	-	-	
54-3	Tashkorgan. CH [2]	-	-	3050	2.7	103	8.6	-	895	6.9	13	117	410	616	904	89	7.9	-	-	-	-	-	-	-	

KZ- Kazakhstan. KG- Kirgizstan. TJ- Tadjikistan. CH- China. [1]-data from [13]; [2]- data from [18]. < - detection limit. dash-not determined.

Table S2. Measured in the field and calculated reservoir temperatures (°C) by different geothermometers.

№ on map	Name/Country	T°C in situ	Improved SiO_2 [35]	Chalcedony [34]	K-Mg [39]	Ca-Mg [38]	Na-Li [36]	Na-K-Ca [37]
			Kazakhstan					
1	Alma-Arasan	35	102	72	64		39	60
2	Nizne-Kamenka	51	77	45	84			59
3	Kazachka	16	38	7	27	54	51	32
5	Tauturgen	29	60	27	61		115	46
6	Kuram	19	57	25	46		138	42
7	Kokpek	17	38	7	22	68	45	17
9	Chunzha	42	68	35	64		13	85
10	Zharkent-Arasan	40	101	70	90		121	91
11	Kerimagash	49	120	91	79	99	-	127
12	Kalkan	33	74	42	69		-	99
13	Kopal-Arasan	40	38	7	93		127	76
15	Chushkala	10	64	31	44	87	-	65
16	Keskelen	24	90	59	64		108	92
17	Merke	20	60	27	44		81	46
			Kirgizstan					
18	Alamedin	46	83	51	76		85	39
20	Dostik	17	55	23	33	57	16	38
30	Kari-Oi	17	90	59	77		-	85
31	Keremetsu	40	64	31	85		-	53
32	Ak-Su	43	133	105	81		104	57
33	Altyn-Arashan F	31	108	78	79		138	76
34	Altyn-Arashan top	40	90	59	57		118	56
36	Djety-Oguz top	20	77	45	76		120	44
37	Djety-Oguz 1bh	40	83	51	129		123	91
38	Djety-Oguz 6bh	37	77	45	121		123	84
39	Djily-Su	37	108	78	89		121	71
40	Jiluu-Su	38	74	42	66		-	56
41	Djuku-Chak	38	88	56	63		80	43
42	Kadjisai	50	83	51	85		-	123
			Tadjikistan					
47	Garm-Chashma, Pamir	60	153	128	102	77	154	154
48	Djelandy, Pamir	79	129	101	114		88	102
49	Khoja-Obi-Garm, STS	94	145	119	136		246	132
50	Faizanbod, STS	31	50	18	53	47	50	101
52	Tamdikul, STS	88	71	39	69		79	152
53	Obigarm, STS	52	154	130	129	68	81	77

Table S3. Chemical and isotopic composition of the associated gases of the Tien-Shan and Pamir.

№ on map	Name, main gas	He	Ar	N_2	O_2	CH_4	CO_2	N_2/Ar	R/R_a	$\delta^{13}C_{CO2}$	$\delta^{15}N$
		vol. %								‰ VPDB	‰
						Thermal water					
10	Zharkent, N_2	0.54	1.3	98	-	0.001	0.24	77		−19.4	1.2
11	Kerimagash, N_2	0.024	1.8	86	9.7	0.35	1.2	47		−29.9	0.4
12	Kalkan, N_2	1.8	1.3	96	-	0.03	0.32	72		−16.9	1.4
13	Kapal-Arasan, N_2	1.06	1.2	97	0.06	0.024	0.18	1.2		−30.2	1.2
18	Alamedin, N_2	0.06	0.9	80	18	0.03	0.15	83	0.05 [P]	−24.6	-
31	Keremetsu, N_2	4.3	1.3	94	0.04	0.18	0.08	70		-	1.8
32	Ak-Su, N_2	0.4	1.6	97	0.02	0.09	0.12	59	0.03 [P]	-	0
37	Djety-Oguz Spa, N_2	4.9	1.5	88	0.12	2.77	0.3	58	0.03 [P]	−21	4.4
38	Djety-Oguz №6, N_2	7.6	1.3	86	0.09	3.03	0.17	64	0.02 [P]	−19.5	4.2
39	Djily-Su, N_2	0.9	1.7	94	-	0.74	0.09	56	0.03 [M]	-	0.5
42	Kadjisai, N_2	0.9	1.5	94	0.14	0.44	1.7	62		−21.6	1.6
47	Garm-Chashma, CO_2	0.00	0.2	1.7	0.01	0.00	98	9	0.1 [S]	−4.5	−2.3
48	Djelandy, N_2	0.06	1.6	95	0.07	0.67	1.8	57	0.07 [S]	-	0.7
49	Khoja-Obi-Garm, N_2	0.4	2.4	78	0.00	1.6	17.5	32	0.02 [B]	-	1
						Cold mineral groundwater					
15	Chushkala, N_2	0.07	0.97	97	0.12	-	1.06	99.8		−23.1	2.1
17	Merke, N_2	0.11	1.4	98	0.12	0.000	0.10	69	0.02 [P]	-	
19	Ak-Su Belorechka, N_2	0.15	0.5	35	0.04	0.20	64.3	73		−9.1	1.8
20	Dostik, N_2	0.13	1.13	89	7.06	0.03	5.4	79		−26.9	1
21	Kara-Keche, N_2-CO_2	-	0.64	56	14	0.000	28.7	87		−10.5	−1.1
22	Beshbelchir, CO_2	0.04	0.13	9.4	0.04	0.008	90	73	1.48 [M]	−6.2	0.6
23	Kol'su, CO_2	0.01	0.04	1.1	-	0.12	94	26	4.3 [R]	−6.5	−3.8
24	Chatirkul, CO_2	0.01	0.04	2.3	0.00	0.03	93	54	1.7 [P]	−10	−2.7
25	Narzan, CO_2	0.00	0.06	2.3	0.00	0.01	97	41		−6.8	−3.2
26	Kara-Shoro, CO_2	0.00	0.03	0.8	0.09	0.02	99	32	0.3 [P]	−3	−4.4
27	Kara-Shoro Up, CO_2+CH_4	0.05	0.2	9.9	-	32	55	53	0.3 [P]	−6.8	−0.1
30	Kari-Oi, N_2	0.15	1.2	98	-	0.04	0.08	79		-	0.6
46	Barshor, CO_2	0.00	0.15	2.0	0.01	0.00	97	13	0.4 [S]	−5.3	−2.1

Data from: [P]- [85,86,87], [M]- [4], [B]- [83], [S]- [84], [R]- [10].