

Sr Isotope, Major, and Trace Element Signatures in Karst Groundwaters

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This online resource contains the following data:

Table S1. Major (Ca, Na, Mg, K) and trace (Sr, Ba, Mn, Li) elements concentration in groundwaters from Southern Carpathians (SCP) and Apuseni Mountains (APS) karst areas, in winter (W) and spring (S) seasons of 2020 and 2021.

Table S2. Anions (Cl⁻, SO₄²⁻, NO₃⁻, HCO₃⁻) concentration, turbidity (TU) and flow rate in groundwaters from Southern Carpathians (SCP) and Apuseni Mountains (APS) karst areas, in winter (W) and spring (S) seasons of 2020 and 2021.

Table S3. Ca/Mg, Ca+Mg, Ca/Ca+Mg, Na+K, Ca/Sr, Ba/Sr molar ratio in groundwaters from Southern Carpathians (SCP) and Apuseni Mountains (APS) karst areas, in winter (W) and spring (S) seasons of 2020 and 2021.

Table S4. ⁸⁷Sr/⁸⁶Sr isotopic ratio in groundwaters from Southern Carpathians (SCP) and Apuseni Mountains (APS) karst areas, in winter (W) and spring (S) seasons of 2020 and 2021.

Table S1. Major (Ca, Na, Mg, K) and trace (Sr, Ba, Mn, Li) elements concentration in groundwaters from Southern Carpathians (SCP) and Apuseni Mountains (APS) karst areas, in winter (W) and spring (S) seasons of 2020 and 2021.

Element	Ca (mg/L)				Na (mg/L)				Mg (mg/L)				K (mg/L)				Sr (µg/L)				Ba (µg/L)				Mn (µg/L)				Li (µg/L)			
Year	2020		2021		2020		2021		2020		2021		2020		2021		2020		2021		2020		2021		2020		2021		2020		2021	
Season	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
SCP																																
GWR1	56.1	62.6	63.1	50.0	1.76	1.64	1.54	1.89	1.14	1.07	1.71	1.55	0.869	0.775	1.190	0.680	24.0	25.3	20.9	24.1	9.31	11.0	10.4	11.4	0.875	0.838	2.17	2.39	0.268	0.711	1.68	1.03
GWR2	48.0	52.1	50.8	49.5	7.73	5.87	4.80	3.61	8.58	6.77	6.09	7.97	1.41	2.11	2.67	1.43	51.2	59.6	36.8	59.3	16.9	19.7	16.0	15.8	1.46	0.376	0.545	0.427	2.00	2.80	1.54	2.43
GWR3	64.3	57.3	77.5	78.7	1.21	2.20	1.16	1.93	8.04	6.41	8.19	5.59	0.575	0.596	0.900	0.470	29.0	31.9	29.0	44.6	12.7	10.7	14.1	16.2	0.506	0.295	0.296	0.296	0.300	0.571	0.459	0.877
GWR5	70.5	82.0	74.0	68.2	0.700	1.55	1.33	0.94	1.19	2.39	2.18	1.17	0.333	0.236	0.950	0.380	33.5	32.1	39.5	46.0	6.70	6.07	7.59	6.65	1.37	0.363	0.132	0.285	0.100	1.25	0.224	0.652
GWR6	107	110	101	99.4	14.2	13.6	18.7	20.4	5.42	4.92	3.95	4.45	0.717	0.561	1.08	0.850	140	149	100	148	20.8	19.1	22.0	18.9	1.39	0.316	0.344	0.485	1.20	1.46	0.953	1.21
GWR7	84.5	80.8	106	88.1	2.17	2.17	1.83	1.72	7.05	6.50	6.84	5.94	0.037	0.057	0.080	0.060	65.2	98.7	66.1	92.7	6.81	8.21	11.4	12.9	15.5	15.5	14.7	12.6	1.35	1.63	1.23	1.60
GWR8	91.0	92.9	112	96.2	0.880	1.00	1.39	0.649	1.89	1.27	1.69	1.60	0.421	0.402	1.19	1.01	50.1	63.6	47.9	75.5	9.50	10.8	10.0	10.8	1.26	0.600	0.200	0.392	0.300	0.599	0.366	0.804
GWR9	45.2	43.3	50.2	37.6	0.569	0.376	0.549	1.05	4.31	3.59	4.21	4.10	0.960	0.620	0.860	0.680	16.5	21.8	16.8	19.8	6.38	6.04	5.08	5.40	0.211	0.311	0.396	0.296	0.456	0.701	0.499	0.902
GWR10	79.0	71.9	77.8	61.2	3.04	3.31	2.89	2.68	2.82	1.01	1.30	1.37	0.871	0.600	0.540	1.10	32.7	36.0	35.6	39.7	7.60	7.01	7.37	7.42	0.807	0.807	0.787	0.361	1.26	0.525	1.33	0.722
GWR11	68.6	75.6	85.7	76.7	1.39	1.27	1.30	1.20	1.30	1.37	1.38	1.77	0.474	0.710	0.490	1.01	46.8	50.1	44.5	59.5	5.65	7.00	7.44	7.59	0.703	0.692	0.813	0.526	0.128	0.478	1.27	0.614
APS																																
GWR12	30.9	36.5	37.4	33.6	0.434	0.585	0.880	0.602	7.54	7.68	6.58	6.83	0.648	0.854	0.480	0.540	44.4	58.9	42.3	77.2	26.7	39.6	29.7	33.8	1.51	0.485	0.861	1.40	0.600	0.990	0.552	0.989
GWR13	71.1	58.1	58.1	51.5	1.10	0.764	1.22	0.878	2.79	2.27	2.35	2.44	0.984	1.05	1.01	1.10	17.9	24.7	22.0	24.3	10.0	10.8	8.83	9.37	1.28	0.273	0.394	0.861	0.100	0.631	0.174	0.744
GWR14	70.6	74.3	78.2	60.4	1.81	3.66	0.75	1.16	1.51	1.50	1.12	1.06	0.742	2.17	1.59	0.800	33.2	48.0	25.6	41.0	13.1	18.2	10.4	18.4	1.33	0.356	1.110	0.883	0.200	0.683	0.259	0.781
GWR15	104	113	82.8	96.1	1.96	1.54	2.62	2.04	2.45	1.90	2.55	2.14	0.720	0.667	0.560	0.622	49.6	62.2	41.3	75.8	16.0	18.0	19.8	21.9	1.81	0.616	0.686	0.543	0.900	1.15	0.520	1.33
GWR16	81.0	82.3	68.9	60.8	0.899	0.623	0.970	1.02	1.35	1.08	1.20	1.02	0.451	0.437	0.950	1.16	19.5	25.5	17.5	27.5	12.2	13.4	11.7	13.7	1.27	0.211	0.213	0.688	0.200	0.597	0.224	0.699
GWR17	115	117	119	98.5	1.76	1.26	1.10	1.65	1.86	1.88	2.07	3.41	1.75	1.58	2.70	1.43	41.2	57.6	37.6	70.9	21.1	16.7	17.3	20.9	0.062	0.241	0.215	0.372	0.497	0.684	0.451	0.902
GWR18	30.2	24.5	24.1	22.2	0.848	0.653	0.630	0.898	9.80	10.7	10.1	10.7	1.50	1.93	1.93	1.17	92.0	148	95.6	151	82.0	112	88.1	114	0.317	0.152	0.322	0.354	3.40	3.60	2.86	3.76
GWR19	65.5	60.5	66.8	52.2	1.72	1.34	1.12	1.77	21.9	23.6	21.8	23.8	1.07	1.08	1.25	1.10	49.6	81.5	55.5	89.0	16.0	22.2	19.0	24.2	1.50	0.185	0.850	0.817	1.90	2.03	1.56	2.16
GWR20	107	128	141	119	30.2	28.6	42.2	33.2	10.8	9.05	10.9	10.7	2.08	2.06	2.40	3.50	381	524	419	658	22.8	26.6	31.3	39.7	1.29	0.245	0.678	1.16	11.9	11.7	12.7	13.4
GWR21	74.5	75.4	78.7	74.5	2.39	1.70	2.14	2.08	9.30	11.7	9.99	10.2	0.530	0.620	1.16	0.830	69.9	89.3	68.0	100	9.0	10.4	10.4	12.8	1.27	0.171	0.638	0.303	0.700	1.13	1.96	1.30
GWR22	47.3	42.7	41.9	31.6	2.01	1.94	1.04	2.55	4.50	4.65	4.65	5.55	0.480	0.481	1.10	1.060	35.2	57.0	33.6	59.1	4.50	5.52	4.84	5.93	0.320	0.169	0.237	0.401	4.10	4.41	3.04	4.64
GWR23	319	327	386	305	17.7	14.2	20.2	20.3	52.5	55.7	46.4	41.6	3.99	4.56	4.74	4.53	494	428	366	538	699	567	737	759	91.1	128	102	120	54.6	57.6	67.9	65.0
GWR24	240	268	311	260	5.89	5.11	6.50	6.85	44.7	48.7	39.4	40.0	1.68	2.05	2.49	1.74	319	300	251	324	136	129	144	131	45.4	27.6	31.7	34.4	13.2	13.0	16.8	15.1
GWR25	87.5	83.8	84.9	69.5	5.53	4.33	5.30	3.73	4.75	4.49	4.42	5.42	0.501	0.589	0.770	0.790	104	102	83.4	127	14.2	18.0	16.9	20.3	0.741	0.179	0.636	0.312	1.26	1.38	2.57	1.98

Table S2. Anions (Cl⁻, SO₄²⁻, NO₃⁻, HCO₃⁻) concentration, turbidity (TU) and flow rate in groundwaters from Southern Carpathians (SCP) and Apuseni Mountains (APS) karst areas, in winter (W) and spring (S) seasons of 2020 and 2021.

Element	Cl ⁻ (mg/L)				SO ₄ ²⁻ (mg/L)				NO ₃ ⁻ (mg/L)				HCO ₃ ⁻ (mg/L)				TU (NTU)				Flow rate (L/min)			
Year	2020		2021		2020		2021		2020		2021		2020		2021		2020		2021		2020		2021	
Season	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
SCP																								
GWR1	1.01	0.95	1.00	0.95	6.77	7.10	8.30	7.50	2.24	1.83	3.10	2.26	201	220	232	183	0.30	2.90	1.15	5.70	15	15	46	20
GWR2	4.00	3.92	2.24	4.22	11.3	10.8	11.3	11.0	8.35	6.88	6.23	5.03	214	226	195	195	0.29	0.82	3.45	0.32	1890	600	1500	600
GWR3	0.93	0.92	0.77	0.93	7.00	6.50	8.20	7.54	2.56	3.00	3.00	2.83	268	232	268	293	0.03	0.10	0.05	0.36	66	60	60	120
GWR5	1.23	0.92	0.83	1.14	6.95	5.45	6.88	6.92	2.20	1.95	1.68	1.93	250	262	268	232	0.08	0.40	0.43	0.46	32400	75000	7200	3000
GWR6	49.5	33.0	52.0	66.0	11.5	9.59	13.2	12.0	5.00	4.76	6.18	4.70	354	336	317	323	0.02	0.03	0.72	0.28	60	36	13	20
GWR7	1.73	1.53	1.43	1.70	12.7	17.0	21.9	15.0	0.10	7.24	8.69	1.42	329	305	305	336	0.40	0.10	0.10	0.40	0.8	2.8	4.0	2.2
GWR8	1.28	1.60	1.02	1.26	10.8	12.3	13.1	12.0	5.40	5.65	3.47	3.64	323	275	317	344	0.06	1.60	0.60	0.13	120	90	20	40
GWR9	0.95	0.98	0.88	0.57	11.8	12.0	12.2	1.85	10.5	11.0	9.55	1.30	140	134	134	134	0.02	2.30	0.20	0.30	1.3	12	2.5	3.0
GWR10	1.79	2.08	2.07	3.00	9.99	8.80	9.33	9.15	5.36	7.08	5.60	8.00	256	238	244	220	0.02	0.02	0.05	0.25	0.5	2.0	3.0	7.5
GWR11	1.20	1.22	1.13	1.35	9.25	9.24	12.3	15.0	3.61	3.68	2.64	2.74	250	238	281	271	0.14	0.15	0.17	0.33	25	30	50	24
APS																								
GWR12	0.90	0.82	0.90	0.94	9.30	8.64	8.40	8.80	1.58	0.38	1.80	1.79	146	171	134	146	1.72	2.00	8.80	10.2	7.5	60	60	40
GWR13	1.74	1.48	1.30	1.25	4.35	4.07	4.63	3.94	4.55	2.69	2.20	2.36	268	214	195	200	0.23	0.28	0.51	0.48	15	15	60	40
GWR14	2.77	5.40	1.20	1.36	3.75	6.28	6.26	6.00	7.25	10.5	3.55	3.39	256	244	244	222	0.05	2.06	0.52	1.54	2.7	60	75	75
GWR15	2.70	2.47	4.33	2.37	7.25	7.31	12.2	10.0	10.6	9.49	14.5	7.90	378	366	281	349	0.04	0.03	2.30	0.32	10	30	300	120
GWR16	1.20	1.12	1.22	0.99	5.30	6.14	5.90	7.40	3.50	1.28	2.65	1.80	295	281	220	220	0.06	0.05	2.71	0.99	6.6	15	15	300
GWR17	1.45	1.35	1.82	1.34	12.0	11.9	13.2	14.0	4.12	4.62	9.38	4.38	366	372	366	366	0.12	0.03	0.07	0.68	5.0	1.0	36	30
GWR18	0.81	0.70	0.78	0.80	5.80	5.82	6.50	6.38	1.65	1.72	1.76	1.87	165	146	136	141	8.10	0.01	0.02	0.31	300	600	300	300
GWR19	2.60	2.74	2.50	2.70	5.75	5.78	6.38	6.23	6.75	6.32	7.03	6.70	354	329	305	326	0.05	0.04	0.10	0.18	6.0	75	20	20
GWR20	90.0	93.0	86.0	100	34.5	34.0	37.0	40.0	4.50	4.90	7.30	12.0	357	390	415	378	0.10	0.02	0.10	0.30	10	10	15	15
GWR21	1.75	1.71	1.27	1.70	12.6	11.8	13.0	14.0	5.50	5.03	4.80	4.95	317	323	317	305	0.10	0.02	0.10	0.10	35	30	150	150
GWR22	5.80	5.85	4.50	6.16	8.00	7.87	8.30	8.94	17.0	17.0	12.6	14.9	171	153	146	124	0.13	0.03	0.99	0.18	6.6	30	150	150
GWR23	7.38	10.2	0.53	7.48	2.10	2.13	1.40	1.38	0.34	0.30	1.37	0.45	1513	1549	1610	1441	0.10	0.10	0.20	0.40	80	40	30	70
GWR24	3.99	1.47	0.54	3.60	7.10	7.26	7.78	7.38	0.40	0.82	0.68	0.54	1166	1269	1281	1208	2.60	0.40	4.00	3.00	60	90	100	150
GWR25	1.76	1.77	1.45	2.11	22.1	22.1	25.0	22.0	4.60	3.32	3.25	8.60	323	293	305	244	0.12	0.10	0.18	0.20	2.5	2.0	26	30

Table S3. Ca/Mg, Ca+Mg, Ca/Ca+Mg, Na+K, Ca/Sr, Ba/Sr molar ratio in groundwaters from Southern Carpathians (SCP) and Apuseni Mountains (APS) karst areas, in winter (W) and spring (S) seasons of 2020 and 2021.

Molar ratio	Ca/Mg (mmol/mmol)				Ca+Mg (mmol)				Ca/Ca+Mg (mmol/mmol)				Na+K (mmol)				Ca/Sr (mmol/mmol)				Ba/Sr (mmol/mmol)			
Year	2020		2021		2020		2021		2020		2021		2020		2021		2020		2021		2020		2021	
Season	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
SCP																								
GWR1	29.8	35.5	22.3	19.6	1.45	1.60	1.64	1.31	0.97	0.97	0.96	0.95	0.099	0.091	0.098	0.100	5115	5410	3019	4526	0.248	0.279	0.317	0.302
GWR2	3.40	4.67	5.05	3.76	1.55	1.58	1.52	1.56	0.77	0.82	0.83	0.79	0.372	0.309	0.277	0.193	2050	1913	5843	1825	0.211	0.211	0.278	0.170
GWR3	4.85	5.42	5.74	8.54	1.94	1.69	2.27	2.19	0.83	0.84	0.85	0.90	0.067	0.111	0.074	0.096	4847	3925	4097	3854	0.279	0.214	0.311	0.232
GWR5	36.0	20.8	20.6	35.2	1.81	2.14	1.94	1.75	0.97	0.95	0.95	0.97	0.039	0.073	0.082	0.051	4603	5582	2212	3243	0.128	0.121	0.123	0.092
GWR6	11.9	13.5	15.5	13.6	2.88	2.93	2.69	2.66	0.92	0.93	0.94	0.93	0.637	0.605	0.842	0.907	1664	1606	3495	1467	0.095	0.082	0.140	0.082
GWR7	7.26	7.54	9.38	9.00	2.40	2.28	2.92	2.44	0.88	0.88	0.90	0.90	0.095	0.096	0.082	0.076	2835	1790	5110	2078	0.067	0.053	0.110	0.089
GWR8	29.2	44.3	40.2	36.4	2.35	2.37	2.86	2.47	0.97	0.98	0.98	0.97	0.049	0.054	0.091	0.054	3969	3194	6552	2785	0.121	0.108	0.133	0.091
GWR9	6.37	7.33	7.23	5.56	1.30	1.23	1.43	1.11	0.86	0.88	0.88	0.85	0.049	0.032	0.046	0.063	5975	4352	4774	4157	0.246	0.177	0.193	0.174
GWR10	17.0	43.2	36.3	27.1	2.09	1.84	1.99	1.58	0.94	0.98	0.97	0.96	0.154	0.159	0.139	0.145	5275	4371	4210	3373	0.148	0.124	0.132	0.119
GWR11	32.0	33.5	37.6	26.3	1.77	1.94	2.20	1.99	0.97	0.97	0.97	0.96	0.072	0.073	0.069	0.078	6608	3301	3413	2817	0.077	0.089	0.107	0.081
ASP																								
GWR12	2.48	2.88	3.45	2.98	1.08	1.23	1.20	1.12	0.71	0.74	0.78	0.75	0.035	0.047	0.051	0.040	1519	1353	1934	951	0.384	0.428	0.448	0.280
GWR13	15.5	15.5	15.0	12.8	1.89	1.54	1.55	1.38	0.94	0.94	0.94	0.93	0.073	0.060	0.079	0.066	8682	5145	5774	4626	0.356	0.279	0.256	0.246
GWR14	28.4	30.1	42.3	34.7	1.82	1.92	2.00	1.55	0.97	0.97	0.98	0.97	0.098	0.215	0.073	0.071	4646	3387	6672	3223	0.252	0.243	0.258	0.286
GWR15	25.6	36.2	19.7	27.2	2.68	2.90	2.17	2.49	0.96	0.97	0.95	0.96	0.104	0.084	0.128	0.104	4564	3981	4388	2772	0.206	0.185	0.307	0.184
GWR16	36.4	46.2	34.7	36.0	2.08	2.10	1.77	1.56	0.97	0.98	0.97	0.97	0.051	0.038	0.066	0.074	9077	7049	8608	4837	0.399	0.335	0.427	0.319
GWR17	37.3	37.6	34.8	17.5	2.94	2.99	3.05	2.60	0.97	0.97	0.97	0.95	0.121	0.095	0.117	0.108	6085	4436	6897	3037	0.327	0.184	0.293	0.188
GWR18	1.87	1.39	1.45	1.26	1.16	1.05	1.02	0.99	0.65	0.58	0.59	0.56	0.075	0.078	0.077	0.069	717	362	551	320	0.569	0.482	0.588	0.481
GWR19	1.82	1.56	1.86	1.33	2.53	2.48	2.56	2.28	0.64	0.61	0.65	0.57	0.102	0.086	0.081	0.105	2887	1623	2631	1282	0.206	0.174	0.219	0.173
GWR20	6.02	8.61	7.87	6.76	3.11	3.58	3.96	3.42	0.86	0.90	0.89	0.87	1.367	1.297	1.897	1.534	613	535	736	396	0.038	0.032	0.048	0.038
GWR21	4.86	3.89	4.78	4.45	2.24	2.36	2.37	2.28	0.83	0.80	0.83	0.82	0.118	0.090	0.123	0.112	2330	1846	2532	1627	0.082	0.074	0.097	0.081
GWR22	6.38	5.56	5.47	3.46	1.37	1.26	1.24	1.02	0.86	0.85	0.85	0.78	0.100	0.096	0.074	0.138	2940	1637	2726	1171	0.082	0.062	0.092	0.064
GWR23	3.68	3.56	5.05	4.45	10.11	10.45	11.54	9.32	0.79	0.78	0.83	0.82	0.873	0.735	0.999	0.997	1409	1670	2304	1240	0.902	0.845	1.284	0.900
GWR24	3.25	3.34	4.79	3.95	7.83	8.69	9.38	8.14	0.76	0.77	0.83	0.80	0.299	0.275	0.346	0.342	1647	1953	2706	1755	0.272	0.274	0.366	0.257
GWR25	11.2	11.3	11.6	7.77	2.38	2.27	2.30	1.96	0.92	0.92	0.92	0.89	0.253	0.203	0.250	0.183	1840	1792	2226	1201	0.087	0.113	0.130	0.102

Table S4. $^{87}\text{Sr}/^{86}\text{Sr}$ isotopic ratio in groundwaters from Southern Carpathians (SCP) and Apuseni Mountains (APS) karst areas, in winter (W) and spring (S) seasons of 2020 and 2021.

$^{87}\text{Sr}/^{86}\text{Sr}$				
Year	2020		2021	
Season	W	S	W	S
SCP				
GWR1	0.7143	0.7145	0.7123	0.7143
GWR2	0.7106	0.7158	0.7092	0.7116
GWR3	0.7102	0.7130	0.7126	0.7088
GWR5	0.7078	0.7080	0.7090	0.7054
GWR6	0.7063	0.7083	0.7060	0.7042
GWR7	0.7062	0.7073	0.7059	0.7069
GWR8	0.7063	0.7074	0.7066	0.7054
GWR9	0.7090	0.7129	0.7081	0.7090
GWR10	0.7083	0.7111	0.7095	0.7104
GWR11	0.7101	0.7075	0.7093	0.7076
APS				
GWR12	0.7079	0.7094	0.7094	0.7092
GWR13	0.7062	0.7099	0.7109	0.7106
GWR14	0.7057	0.7095	0.7083	0.7095
GWR15	0.7060	0.7097	0.7084	0.7101
GWR16	0.7081	0.7079	0.7090	0.7114
GWR17	0.7038	0.7089	0.7074	0.7083
GWR18	0.7109	0.7081	0.7083	0.7113
GWR19	0.7114	0.7100	0.7090	0.7095
GWR20	0.7067	0.7075	0.7070	0.7083
GWR21	0.7114	0.7088	0.7066	0.7064
GWR22	0.7149	0.7104	0.7084	0.7105
GWR23	0.7090	0.7082	0.7104	0.7097
GWR24	0.7070	0.7100	0.7108	0.7124
GWR25	0.7046	0.7071	0.7069	0.7058