Table S1. Analytical results of major elements and organic carbon contents (in wt.%).

Sample Number	Lithology	Al_2O_3	CaO	Cl	Fe	MgO	Mn	P_2O_5	SiO_2	LOI	Mn/Fe	P/Mn	TOC	TC	TOC/TC
		%	%	μg/g	%	%	%	%	%	%			%	%	
H1	Micritic limestone	0.8	50.15	124	0.56	0.37	0.05	0.022	4.75	39.94	0.09	0.192	0.47	11.18	0.04
H2	Carbonaceous limestone	4.44	20.79	66.8	1.79	1.61	0.49	0.056	48.12	18.79	0.27	0.050	1.49	5.55	0.27
H3	Carbonaceous limestone	5.98	21.7	75.4	1.95	1.6	0.26	0.053	43.44	19.49	0.13	0.089	2.1	5.8	0.36
H4	Carbonaceous limestone	5.12	29.35	75.4	1.9	2.51	0.49	0.059	29.44	26.08	0.26	0.053	1.36	7.26	0.19
H5	Carbonaceous limestone	4.76	31.51	43.6	1.39	1.21	0.2	0.051	28.9	27.12	0.14	0.111	1.59	7.93	0.20
H6	Carbonaceous limestone	2.55	40.21	61.7	0.93	0.84	0.13	0.038	17.23	33.5	0.14	0.128	1.29	9.79	0.13
H7	Carbonaceous limestone	3.11	35.93	60.2	1.12	1.01	0.077	0.073	24.33	30.36	0.07	0.414	1.55	9.11	0.17
H8	Carbonaceous limestone	4.52	28.79	65.3	1.63	1.37	0.099	0.075	33.22	25.66	0.06	0.331	2.07	8.07	0.26
H9	Carbonaceous limestone	4.71	30.05	62.3	1.42	1.29	0.27	0.056	31.69	26.28	0.19	0.091	1.6	8.11	0.20
H10	Carbonaceous limestone	6.22	26.61	68.9	1.82	3.49	0.75	0.09	32.1	24.44	0.41	0.052	1.03	6.9	0.15
H10-1	Mn-bearing Carbonaceous limestone	3.1	30.81	73.2	0.67	2.14	2.23	0.079	29.01	27.86	3.33	0.015	0.42	8	0.05
H11	Rhodochrosite	0.94	18.04	112	1.09	3.23	20.46	0.15	15.03	30.96	18.77	0.003	0.73	9.64	0.08
H12	Mn-bearing Carbonaceous limestone	4.29	31.98	48.4	1.67	1.19	0.47	0.083	27.82	26.75	0.28	0.077	1.76	7.9	0.22
H12-1	Carbonaceous argillaceous limestone	4.73	31.66	50.3	2.3	1.16	0.51	0.07	28.84	17.58	0.22	0.060	2.11	5.15	0.41
H13	Carbonaceous argillaceous limestone	5.98	30.02	38.8	1.59	1.53	0.25	0.047	29.16	27.42	0.16	0.082	1.69	8.47	0.20
H14	Carbonaceous argillaceous limestone	10.92	16.66	41	1.54	3.23	0.077	0.1	43.13	27.09	0.05	0.567	1.62	8.15	0.20
H15	Carbonaceous argillaceous limestone	7.22	23.26	52	2.54	2.42	0.086	0.075	37.89	21.15	0.03	0.381	1.82	6.16	0.30
H16	Carbonaceous argillaceous limestone	7.15	19.2	29.6	2.45	2.19	0.058	0.061	45.05	17.91	0.02	0.459	1.86	5.28	0.35
H17	Carbonaceous	4.12	36.39	53.4	1.55	1.44	0.059	0.045	21.66	30.67	0.04	0.333	1.31	9	0.15

	argillaceous limestone														
H18	Carbonaceous argillaceous limestone	1.22	46.43	59.2	0.5	0.54	0.035	0.035	10.28	37.35	0.07	0.437	0.88	10.97	0.08
H19	Carbonaceous argillaceous limestone	3.31	38.46	54	1	1.09	0.11	0.04	19.86	32.03	0.11	0.159	1.26	9.68	0.13
H20	Carbonaceous argillaceous limestone	6.75	23.03	42.1	2.04	2.13	0.38	0.053	39.47	20.99	0.19	0.061	1.94	6.57	0.30
H21	Mn-bearing Carbonaceous limestone	6.37	24.13	69.9	1.44	2.09	0.92	0.076	39.35	21.87	0.64	0.036	0.93	6.23	0.15
H22	Rhodochrosite	1.06	21.62	124	1.51	3.64	16.26	0.16	15.12	30.51	10.77	0.004	1.2	9.66	0.12
H23	Mn-bearing Carbonaceous limestone	5.68	21	66.3	2.09	2.21	1.41	0.065	42.12	20.2	0.67	0.020	1.75	6.4	0.27
H24	Carbonaceous argillaceous limestone	5.94	22.41	38.1	1.79	1.8	0.85	0.073	41.97	20.34	0.47	0.037	1.03	5.82	0.18
H25	Carbonaceous argillaceous limestone	5.77	18.46	70.5	2.72	2.01	1.43	0.081	45.53	17.88	0.53	0.025	2.77	5.88	0.47
H26	Carbonaceous argillaceous limestone	5.65	22.06	53.6	2.5	1.78	0.87	0.073	41.96	20.09	0.35	0.037	2.07	6.11	0.34
H27	Rhodochrosite	2.05	22.24	53.4	2.97	3.78	7.86	0.27	26.04	26.36	2.65	0.015	2.34	8.49	0.28
H28	Carbonaceous argillaceous limestone	7.44	20.49	66.2	2.23	2.03	0.56	0.096	42.5	19.34	0.25	0.075	1.04	5.28	0.20
H29	Carbonaceous argillaceous limestone	6.27	22.09	43.2	2.14	1.57	0.15	0.07	44.18	19.81	0.07	0.204	1.48	5.72	0.26
H30	Carbonaceous argillaceous limestone	5.68	21.96	74.9	1.96	1.85	0.14	0.063	45.55	19.63	0.07	0.196	0.85	5.42	0.16
H31	Calcarenite	1.4	48.94	89.6	0.54	0.72	0.08	0.033	6.9	38.88	0.15	0.180	0.31	11.2	0.03

Table S2. Analytical results of trace elements (in ppm).

Sample Number	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H10-1	H11	H12	H12-1	H13	H14	H15	H16
Li	8.61	33.8	24.6	30.3	13.2	8.86	10.2	13.8	19.5	35	12.8	7.92	18.9	32.3	16.2	14.5	31.8	27.2
Be	0.098	0.289	0.345	0.304	0.234	0.165	0.268	0.299	0.28	0.343	0.193	0.279	0.356	0.551	0.265	0.288	0.364	0.305
Sc	1.36	9.05	13.4	12.8	9.1	5.86	6.95	5.08	10.5	9.85	6.31	2.32	7.35	8.88	10	10.2	17.1	14.3
V	10.7	104	113	92.8	72.8	56.4	75	84.9	81.5	77.7	33.6	124	85.7	173	79.1	77.7	121	139
Co	1.36	9.1	9.71	12.8	7.03	4.89	6.24	9.82	7.67	11.5	4.13	57.6	7.41	12.1	7.95	8.59	11.8	12.3
Ni	2.56	19.3	18.8	43.6	14.3	9.46	12.9	18.9	14.1	24.7	5.65	16.8	13.7	23.8	14.1	14.9	15.6	18.4
Cu	5.48	34.8	46.3	35.8	30.1	22.1	31.9	43.5	34.3	28	17.1	21.4	34.3	57	37.2	34.7	43.5	57
Zn	17.5	61.1	61.9	49.7	42	29	36.8	43.8	39.8	58.3	26	36.7	50.3	99.3	45.7	49.6	61.9	61.1
Ga	1.35	5.71	6.87	6.63	5.61	3.85	4.69	5.86	5.46	6.25	3.84	3.69	6.88	10.6	5.31	5.7	8.3	7.94
Rb	5.06	10.6	14	8.48	9.54	5.08	6.8	8.8	10.1	8.47	7.65	3.98	12	22	9.43	10.8	11.3	12.3
Sr	607	582	663	1170	1286	1683	1888	1301	1259	1624	1469	1254	1495	1119	1495	1496	1164	1052
Zr	9.09	28.5	24.9	31.2	23.5	14.1	19.9	28.8	22.6	34.1	21.3	21.6	26	61.1	26.2	25.1	35.4	32.2
Nb	0.716	1.47	0.991	1.51	0.962	0.888	1.05	1.78	1.06	1.73	1.06	1.18	1.37	2.9	1.16	1.02	1.74	1.25
Mo	5.86	7.65	15	7.22	7.08	6.12	9.92	11	14.4	5.04	1.26	6.29	11.8	37.5	7.07	6.45	6.8	7.96
Cd	0.534	1.77	1.4	0.851	0.713	0.573	1.39	1.38	0.961	1.07	0.097	0.311	1.12	3.58	0.963	0.846	0.892	0.935
Cs	1.41	2.84	3.02	1.5	1.73	0.697	0.84	0.981	2.52	1.77	0.948	0.567	1.69	3.84	2.05	0.984	1.37	1.07
Ba	51.8	112	167	174	260	173	245	223	204	212	183	107	327	569	225	257	261	291
Hf	0.345	0.453	0.293	0.603	0.35	0.079	0.158	0.594	0.198	0.705	0.157	ND	0.373	1.71	0.198	0.215	0.606	0.443
Ta	1.04	0.337	0.279	0.463	0.483	0.281	0.46	1	0.32	0.372	0.286	0.084	0.373	0.309	0.228	0.301	0.342	0.145
W	0.14	0.484	0.579	0.554	0.44	0.252	0.403	0.492	0.475	1.02	0.768	2.53	0.706	1.46	0.467	0.432	0.376	0.363
Tl	0.111	0.524	0.671	0.329	0.308	0.251	0.41	0.449	0.332	0.198	0.137	0.389	0.35	0.726	0.3	0.389	0.316	0.359
Pb	4.76	9.99	8.5	6.55	5.97	5.5	7.27	9.22	7.79	7.38	5.68	5.61	8.07	13.9	6.94	7.1	7.79	8.03
Bi	0.079	0.067	0.071	0.059	ND	ND	ND	0.076	0.058	0.06	ND	ND	0.075	0.106	ND	0.056	0.057	0.058
Th	ND	1.81	1.34	1.43	1.07	0.907	1.37	1.48	1.41	2.07	1.49	ND	2.34	3.47	1.41	1.18	2.06	2
U	1.07	2.86	2.84	2.31	3.28	3.35	3.36	3.18	3.27	1.65	0.998	2.66	4.5	3.7	2.78	2.95	3.7	3.35
La	1.66	9.35	10	13	11.6	13.5	12.4	14.3	12.1	7.3	8.98	12.2	16.6	12.1	12.1	12.8	15.8	11.5

Ce	2.28	17.2	17.7	24.4	18.9	22	22.1	25.7	21.3	12.9	11.8	33.1	30.7	23.9	20.5	19.8	27.6	21.8
Pr	0.43	2.2	2.2	2.78	2.32	2.5	2.61	3.01	2.52	1.83	2.15	2.65	3.4	3	2.41	2.36	3.13	2.61
Nd	2.01	9.22	8.93	11.2	9.15	10.3	10.2	12.1	10.1	7.74	9.16	10.8	13.5	12.5	10.1	9.61	12.7	10.9
Sm	0.442	2.13	1.85	2.34	1.74	1.72	1.89	2.31	2.02	1.89	1.95	2.33	2.44	2.64	1.97	1.84	2.65	2.26
Eu	0.115	0.536	0.438	0.618	0.41	0.416	0.446	0.555	0.494	0.57	0.447	0.635	0.499	0.576	0.562	0.498	0.63	0.468
Gd	0.609	2.31	1.9	2.42	1.85	1.79	1.99	2.17	2.03	2.05	2.12	2.88	2.24	2.56	2.07	1.92	2.65	2.41
Tb	0.103	0.361	0.293	0.371	0.272	0.236	0.288	0.338	0.301	0.311	0.334	0.453	0.323	0.418	0.324	0.281	0.408	0.352
Dy	0.748	2.44	1.94	2.41	1.73	1.57	1.92	2.13	1.98	2.11	2.18	2.98	2	2.82	2.12	1.81	2.75	2.33
Ho	0.171	0.481	0.422	0.486	0.372	0.325	0.396	0.465	0.439	0.436	0.453	0.611	0.424	0.589	0.437	0.395	0.587	0.486
Er	0.547	1.38	1.17	1.37	1.05	0.956	1.12	1.32	1.18	1.3	1.36	1.71	1.22	1.8	1.27	1.16	1.66	1.45
Tm	0.075	0.192	0.169	0.199	0.154	0.132	0.172	0.185	0.169	0.196	0.187	0.227	0.168	0.271	0.181	0.171	0.242	0.211
Yb	0.531	1.27	1.13	1.22	0.963	0.839	1.08	1.18	1.11	1.21	1.24	1.41	1.11	1.78	1.19	1.07	1.53	1.34
Lu	0.08	0.183	0.169	0.179	0.139	0.124	0.165	0.186	0.165	0.191	0.185	0.201	0.159	0.263	0.166	0.176	0.245	0.188
Y	6.87	15.5	13.3	16	12.5	12.1	13.7	14.3	13.9	13.6	15.4	16.2	13.4	16.4	14.8	13.9	18.4	15
REE+Y	16.67	64.75	61.61	78.99	63.15	68.51	70.48	80.25	69.81	53.63	57.95	88.39	88.18	81.62	70.2	67.79	90.98	73.31
LREE/HREE	0.71	1.68	2.01	2.2	2.32	2.79	2.38	2.6	2.28	1.51	1.47	2.31	3.19	2.03	2.11	2.25	2.2	2.08
δCe	0.62	0.87	0.87	0.94	0.84	0.87	0.9	0.9	0.89	0.81	0.62	1.34	0.94	0.91	0.87	0.83	0.9	0.92
δEu	1.01	1.13	1.09	1.22	1.07	1.11	1.08	1.17	1.14	1.35	1.03	1.13	1	1.04	1.3	1.24	1.12	0.94
Y/Y*	1.53	1.14	1.17	1.18	1.24	1.35	1.25	1.15	1.19	1.13	1.24	0.96	1.16	1.01	1.23	1.31	1.16	1.12
Y/Ho	40.18	32.22	31.52	32.92	33.60	37.23	34.60	30.75	31.66	31.19	34.00	26.51	31.60	27.84	33.87	35.19	31.35	30.86

Note: ND = Not detected; $\delta Ce=[2Ce/(La+Pr)]_{PAAS}$, $\delta Eu=[2Eu/(Sm+Gd)]_{PAAS}$, $Y/Y^*=[2Y/(Dy+Ho)]_{PAAS}$, PAAS data from McLennan (1989) [23].

Table S2. Continued.

Sample Number	H17	H18	H19	H20	H21	H22	H23	H24	H25	H26	H27	H28	H29	H30	H31
Li	17.1	5.6	12.9	28.5	28.4	10.4	22.3	27.2	25.2	24	12.7	34.6	25.2	29.3	5.71
Be	0.252	0.105	0.194	0.42	0.461	0.295	0.295	0.399	0.376	0.46	0.357	0.58	0.337	0.349	0.086
Sc	8.54	2.97	6.87	11.9	8.48	2.71	13	10.3	11	9.97	4.96	11.1	9.14	10.1	2.24

V	77.4	40.1	58.4	138	58.3	83.9	95	63.8	99.6	88.8	89.3	74.8	85.4	63.5	13.9
Co	7.49	3.47	5.84	9.28	9.97	25.4	9.17	8.39	12.6	9.83	19.2	10	9.81	8.92	1.51
Ni	11.3	8.37	13	20.9	16.8	12.3	17.2	14.3	22.9	20	19.3	14.3	18.4	13.5	2.39
Cu	35.2	14.3	24.8	45.8	21.9	17.8	54.4	29.2	36.2	34.8	32.2	44.2	32.9	33.3	5.24
Zn	37.4	23.2	32.9	78.9	56.6	27.3	75	45.3	79.8	70.4	35.9	70.4	66.6	51.7	11.8
Ga	5.06	2.53	4.9	7.38	7.18	3.54	6.44	6.42	7.09	7.11	5.13	9.16	6.83	6.63	1.37
Rb	7.18	3.99	6.61	12.1	12	2.83	14.3	12.8	11.4	11.5	5.39	16.8	14.9	14.7	3.72
Sr	1902	3311	2269	1253	1350	1125	1077	1106	1210	1057	1139	974	940	706	873
Zr	25.5	7.7	14.2	31.7	44.5	15.2	30.8	28.7	41.2	42.7	20.8	60.4	33.3	34.4	7.68
Nb	1.62	0.395	0.74	1.56	2.61	0.928	1.15	1.28	1.66	2.11	1.23	2.7	1.14	1.25	0.278
Mo	5.39	4.66	8.01	31.3	3.39	27.7	11.5	1.92	9.96	8.88	13.1	7.17	5.79	0.633	0.929
Cd	0.603	0.703	0.776	2.86	0.53	0.452	2.41	0.483	2.62	2.22	1.52	2.16	1.41	0.161	0.183
Cs	0.663	0.353	0.78	1.56	1.56	0.704	1.61	1.47	1.42	1.95	0.593	3.1	2.12	1.64	0.527
Ba	184	141	193	270	271	91.6	314	306	194	312	75	191	155	157	41
Hf	0.216	ND	ND	0.514	1.14	ND	0.419	0.291	0.752	0.879	ND	1.6	0.459	0.53	ND
Ta	0.319	0.322	0.226	0.207	0.331	0.097	0.153	0.122	0.165	0.187	0.081	0.329	0.097	0.116	0.432
W	0.182	0.135	0.307	0.766	0.753	3.44	1.09	0.963	0.826	0.738	1.14	0.797	1.32	1.16	0.431
Tl	0.247	0.179	0.212	0.538	0.205	0.166	0.517	0.34	0.551	0.594	0.194	0.489	0.437	0.184	ND
Pb	7.75	4.52	5.93	10.4	8.65	5.37	7.67	7.8	9.11	10.3	9.64	9.98	7.4	7.51	3.65
Bi	ND	ND	ND	0.083	0.08	ND	0.067	0.057	0.07	0.08	0.056	0.094	0.062	0.053	ND
Th	1.64	ND	0.912	2.51	3.82	ND	1.85	1.79	2.88	2.99	1.13	3.4	1.62	1.6	ND
U	3.82	3.81	3.79	3.74	1.84	2.19	2.87	1.19	3.06	2.95	1.62	3	2.08	1.27	3.29
La	12.9	10.9	16.7	11.5	9.35	12.2	13.3	9.82	12.8	12.2	14.7	12.1	9.82	10.3	1.62
Ce	21.3	17.1	28.5	22.2	17.2	35	24.3	14.7	26.4	24.1	43.9	24.8	15.8	13.7	2.01
Pr	2.41	1.83	3.11	2.8	2.38	2.53	2.97	2.51	3.11	3.07	3.84	3.29	2.39	2.5	0.404
Nd	9.53	7.73	12	11.4	9.94	10.7	12.1	10.4	12.9	12.8	15.7	14.1	10.3	10.4	1.99
Sm	1.78	1.29	2.07	2.4	2.3	2.29	2.51	2.32	2.91	2.88	3.74	3.54	2.39	2.55	0.459
Eu	0.42	0.317	0.483	0.513	0.563	0.621	0.572	0.536	0.81	0.714	1.1	0.789	0.67	0.619	0.16
Gd	1.92	1.28	1.93	2.46	2.59	2.66	2.86	2.47	3.1	3.03	4.25	3.91	2.6	2.84	0.64
Tb	0.283	0.171	0.267	0.378	0.417	0.409	0.432	0.379	0.498	0.447	0.656	0.617	0.395	0.443	0.108

Dy	1.99	1.09	1.67	2.44	2.81	2.59	2.8	2.45	3.19	3.07	4.14	4.18	2.64	2.89	0.778
Ho	0.413	0.224	0.337	0.488	0.575	0.537	0.563	0.507	0.629	0.587	0.76	0.863	0.511	0.596	0.171
Er	1.25	0.676	0.955	1.47	1.69	1.49	1.67	1.41	1.76	1.69	1.98	2.53	1.51	1.74	0.511
Tm	0.175	0.088	0.129	0.206	0.257	0.196	0.228	0.206	0.254	0.228	0.263	0.352	0.21	0.249	0.073
Yb	1.15	0.58	0.827	1.38	1.68	1.21	1.49	1.32	1.65	1.54	1.57	2.39	1.41	1.62	0.501
Lu	0.181	0.083	0.125	0.218	0.248	0.163	0.221	0.198	0.244	0.215	0.219	0.355	0.217	0.246	0.083
Y	14.2	8.83	11.1	15	17.1	14.3	17.7	15.6	18.8	17.6	21.7	25.3	16.1	17.6	6.09
REE+Y	69.9	52.19	80.2	74.85	69.1	86.9	83.72	64.83	89.06	84.17	118.52	99.12	66.96	68.29	15.6
LREE/HREE	2.24	3.01	3.63	2.11	1.52	2.69	1.99	1.64	1.96	1.96	2.33	1.45	1.62	1.42	0.74
δCe	0.88	0.87	0.91	0.9	0.84	1.45	0.89	0.68	0.97	0.91	1.35	0.9	0.75	0.62	0.57
δEu	1.06	1.16	1.14	0.99	1.07	1.17	0.99	1.05	1.26	1.13	1.28	0.99	1.26	1.07	1.35
Y/Y*	1.25	1.43	1.18	1.1	1.07	0.97	1.12	1.12	1.06	1.04	0.97	1.06	1.1	1.07	1.33
Y/Ho	34.38	39.42	32.94	30.74	29.74	26.63	31.44	30.77	29.89	29.98	28.55	29.32	31.51	29.53	35.61

Note: ND = Not detected; $\delta Ce=[2Ce/(La+Pr)]_{PAAS}$, $\delta Eu=[2Eu/(Sm+Gd)]_{PAAS}$, $Y/Y^*=[2Y/(Dy+Ho)]_{PAAS}$, PAAS data from McLennan (1989) [23].