Table S3 . Volcanic rock compositions, r. Khikey

	Number									
	1	2	3	4	5	6	7	8	9	10
	No sample									
	2009	2013	2014	2016	2017b	2017c	2019	2018	2018-1	2019
	Formation									
Component	iv	sv	sv	sv	gd_2	gd_2	hk	**hk**	**G**	tk bas
SiO_2	52.64	53.90	51.69	53.60	46.67	46.07	53.31	57.83	57.23	50.96
TiO_2	2.19	1.83	1.58	1.87	1.10	1.13	1.00	1.02	0.98	0.96
Al_2O_3	15.02	16.08	15.39	15.24	8.18	8.04	15.68	17.19	16.87	16.30
FeO	11.25	9.00	10.40	9.80	13.95	13.80	9.50	7.98	6.62	9.97
MnO	0.17	0.17	0.21	0.14	0.21	0.21	0.19	0.17	0.11	0.20
MgO	5.48	5.08	6.66	5.25	22.5	22.6	6.09	5.24	4.35	8.49
CaO	7.00	9.19	10.58	9.33	6.19	6.30	11.47	6.91	9.88	11.00
Na_2O	3.37	3.77	2.34	2.74	0.74	0.70	2.00	1.28	1.48	1.77
K_2O	2.25	1.06	0.48	1.23	0.14	0.17	0.76	1.32	1.50	0.65
P_2O_5	0.19	0.25	0.21	0.35	0.09	0.11	0.10	0.20	0.17	0.09
Total	99.2	100.3	99.5	99.6	99.8	99.1	100.1	99.1	99.2	100.4
Rb	76.26	25.20	14.88	26.38	8.23	9.47	13.80	49.84	56.19	12.08
Ba	1110	385	272	400	35.6	38.0	298	227	322	411
Th	2.40	3.11	2.47	2.97	0.83	0.87	3.88	6.92	5.83	0.79
U	0.55	0.77	0.63	0.73	0.22	0.23	0.99	1.89	2.09	0.19
Nb	13.65	14.14	11.10	13.75	4.65	4.62	8.48	13.53	11.93	3.21
Ta	0.87	0.87	0.67	0.79	0.29	0.30	0.55	0.86	0.78	0.21
La	21.5	24.8	18.6	24.7	5.75	5.93	18.7	30.5	31.6	6.69
Ce	47.7	49.2	38.9	52.0	13.9	14.4	37.5	61.0	59.1	14.4
Pb	4.87	5.03	4.09	4.81	1.39	1.76	4.70	7.37	11.33	1.98
Pr	6.06	6.36	5.00	6.60	2.00	2.07	4.58	7.38	6.71	1.94
Nd	26.6	28.0	21.7	28.6	9.48	9.94	19.0	30.3	26.8	9.01
Sr	692	239	445	412	127	124	262	230	129	322
Sm	6.00	6.22	5.04	6.36	2.57	2.70	4.14	6.00	5.44	2.44
Zr	209	209	168	216	70.4	71.3	129	186	146	66.5
Hf	4.87	5.04	4.18	5.13	1.82	1.90	3.40	4.77	3.54	1.78
Eu	1.95	1.97	1.61	2.03	0.86	0.89	1.15	1.63	1.51	1.00
Ti	11898	10710	9547	10907	6590	6715	6053	6434	6389	5795
Gd	6.26	6.20	5.37	6.55	2.85	2.97	4.45	5.81	5.20	2.92
Tb	0.93	0.98	0.82	0.98	0.46	0.46	0.70	0.83	0.77	0.50
Dy	5.76	5.94	5.21	5.88	2.71	2.85	4.60	5.23	4.94	3.35
Ho	1.11	1.12	1.01	1.14	0.52	0.54	0.91	1.03	0.96	0.67
Y	29.36	29.98	26.41	29.99	13.77	13.76	24.77	27.36	24.90	18.03
Er	3.06	3.16	2.82	3.13	1.42	1.46	2.67	2.93	2.41	1.97
Yb	2.68	2.85	2.55	2.74	1.18	1.25	2.54	2.82	2.66	1.87
Tm	0.42	0.41	0.39	0.42	0.18	0.19	0.38	0.41	0.37	0.28
Lu	0.39	0.42	0.38	0.40	0.16	0.18	0.38	0.40	0.36	0.28
Ni	53.6	37.4	89.8	42.3	1193	1206	21.8	101	72.4	136
Cu	73.6	40.3	79.1	36.2	106	112	64.3	64.8	43.1	115
Zn	121	94.9	118	119	110	121	82.5	113	94.9	82.5
Co	209	209	168	216	70.4	71.3	129	186	146	66.5

Table S3. Continuation 2.

	Number									
	11	12	13	14	15	16	17	18	19	20
	No sample									
	2019/1	2029/1	2035/2	2025/1	2026/4	2026/7	2027/1	2027/2	2010	2011
	Formation									
Component	tk bas	tk	tk pbas	nd	nd	nd	nd	nd	nd	nd
SiO_2	49.07	49.89	52.09	52.00	50.41	50.53	50.57	50.00	52.53	53.24
TiO_2	1.01	0.97	0.36	1.08	1.13	1.14	1.02	1.00	0.88	0.88
Al_2O_3	15.51	N	6.34	16.12	15.15	15.53	15.89	16.34	15.78	15.96
FeO	10.23	10.09	6.92	10.83	11.21	10.81	11.03	10.10	9.04	9.02
MnO	0.12	0.14	0.15	0.17	0.24	0.14	0.22	0.19	0.15	0.16
MgO	9.62	8.08	15.1	6.29	7.73	6.73	6.33	6.12	6.99	7.05
CaO	11.20	12.45	16.74	10.62	8.95	12.55	11.15	11.70	10.79	9.67
Na_2O	1.76	1.80	0.51	2.03	2.98	1.89	2.39	2.43	2.47	3.33
K_2O	0.47	0.18	0.92	0.71	1.16	0.22	0.96	0.89	0.60	0.70
P_2O_5	0.12	0.14	0.02	0.09	0.17	0.14	0.19	0.28	0.09	0.10
Total	99.1	99.8	99.2	99.9	99.7	99.8	99.0	99.3	100.1	
Rb	8.94	1.53	19.95	11.96	33.59	8.08	24.18	16.48	19.35	19.91
Ba	202	137	550	292	357	110	320	311	305	267
Th	0.66	0.90	0.43	3.45	2.12	2.15	2.53	2.61	2.82	3.10
U	0.15	0.21	0.09	0.87	0.70	0.71	1.23	1.28	0.64	0.77
Nb	2.84	4.07	1.09	8.56	5.95	6.10	7.69	7.61	6.96	7.97
Ta	0.17	0.21	0.08	0.54	0.37	0.40	0.46	0.45	0.41	0.45
La	5.99	7.32	3.00	16.7	11.9	12.6	16.0	16.1	16.8	18.2
Ce	12.4	16.0	7.28	35.0	24.9	26.0	32.9	33.2	33.1	36.6
Pb	2.17	1.23	1.14	3.89	2.63	2.92	4.10	4.54	2.35	2.66
Pr	1.78	2.17	1.11	4.37	3.22	3.39	4.14	4.20		4.43
Nd	8.24	10.1	5.44	18.3	14.3	14.9	17.1	17.5	16.7	18.0
Sr	336	252	268	263	304	229	291	303	437	483
Sm	2.23	2.72	1.58	4.22	3.50	3.67	3.79	4.07	3.65	3.86
Zr	56.7	70.4	22.6	143	107	109	119	122	111	126
Hf	1.57	1.91	0.71	3.58	2.83	2.86	2.95	3.01	2.86	3.29
Eu	0.92	0.99	0.46	1.21	1.10	1.16	1.12	1.14	1.06	1.15
Ti	5347	6101	2267	6507	6894	6936	6207	6077	5169	5579
Gd	2.70	3.18	1.90	4.63	4.15	4.20	4.23	4.50	3.76	4.10
Tb	0.44	0.51	0.32	0.72	0.70	0.69	0.71	0.74	0.60	0.63
Dy	3.02	3.45	2.14	4.70	4.56	4.63	4.87	5.07	3.91	4.20
Ho	0.62	0.71	0.43	0.97	0.94	0.95	1.03	1.10	0.80	0.85
Y	16.14	18.15	10.78	25.86	24.91	25.00	27.50	29.38	21.05	22.47
Er	1.75	2.06	1.20	2.70	2.70	2.76	3.10	3.37	2.29	2.34
Yb	1.69	1.97	1.09	2.68	2.69	2.73	3.15	3.39	2.15	2.35
Tm	0.26	0.29	0.16	0.39	0.39	0.40	0.45	0.47	0.32	0.34
Lu	0.25	0.29	0.15	0.39	0.39	0.39	0.47	0.50	0.33	0.34
Ni	143	105	56.2	65.3	104	102	70.9	69.2	45.4	41.4
Cu	107	110	8.49	90.1	120	167	95.0	72.4	49.0	56.0
Zn	78.6	102	57.8	94.8	115	197	125	119	84.7	101
Co	56.7	70.4	22.6	143	107	109	119	122	111	126

Table S3. Continuation 3.

	Number									
	21	22	23	24	25	26	27	28	29	30
	N sample									
	2011/1	2011/2	2011/3	2011/4	2011/5	2011/7	2011/6	2011/8	2011/9	2012
	Formation									
Component	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
SiO_2	55.89	53.91	51.76	51.31	50.42	53.63	54.06	51.79	53.61	54.75
TiO_2	0.88	0.90	0.94	1.02	0.97	0.91	0.91	0.99	1.05	0.95
Al_2O_3	14.86	15.99	16.40	15.56	16.43	16.09	15.83	15.58	15.16	15.57
FeO	8.56	9.20	8.24	10.07	10.45	8.52	9.37	9.77	10.03	8.60
MnO	0.12	0.16	0.13	0.20	0.21	0.17	0.18	0.11	0.21	0.17
MgO	6.23	6.90	5.95	7.59	7.68	6.75	6.56	6.63	6.39	6.67
CaO	9.29	9.75	11.66	9.63	9.41	9.70	10.10	10.27	8.94	9.07
Na_2O	2.94	2.79	2.59	2.16	2.85	3.26	3.07	2.71	2.78	2.66
K_2O	1.10	0.50	1.42	1.10	0.34	0.83	0.19	1.01	1.49	1.76
P_2O_5	0.09	0.08	0.09	0.12	0.13	0.11	0.10	0.12	0.11	0.08
Total	100.0	100.2	99.2	98.8	98.9	100.0	100.4	99.0	99.8	100.3
Rb	47.53	11.49	29.08	35.70	6.34	19.80	5.36	25.49	42.29	53.61
Ba	331	209	455	789	97.7	201	44.7	350	451	469
Th	3.04	3.09	2.53	3.09	3.33	3.37	3.08	3.78	3.90	3.70
U	0.68	0.74	0.64	0.72	0.75	0.71	0.69	0.96	1.07	1.05
Nb	7.52	7.57	6.50	8.66	8.17	7.96	7.47	8.86	8.73	8.37
Ta	0.44	0.45	0.38	0.49	0.48	0.50	0.45	0.57	0.55	0.55
La	15.2	18.1	14.7	17.8	18.0	17.9	16.5	18.7	19.1	18.2
Ce	31.9	36.1	30.3	35.7	37.1	36.2	33.8	38.3	39.8	37.0
Pb	6.88	2.58	4.89	2.31	2.96	1.63	2.82	4.04	6.06	5.15
Pr	4.01	4.40	3.82	4.46	4.66	4.47	4.21	4.72	4.84	4.51
Nd	16.7	18.0	15.8	18.3	19.2	18.8	17.7	19.2	20.1	18.9
Sr	265	170	406	400	123	113	97.7	507	357	307
Sm	3.70	3.91	3.52	3.77	4.15	4.15	3.87	4.22	4.41	4.02
Zr	122	125	94.9	126	128	130	125	128	143	127
Hf	3.12	3.24	2.50	3.12	3.34	3.35	3.19	3.28	3.77	3.28
Eu	1.02	1.11	1.07	1.11	1.20	1.11	1.16	1.14	1.16	1.10
Ti	5246	5453	4995	5801	5982	5652	5469	5956	6161	5753
Gd	3.89	4.16	3.53	4.03	4.32	4.32	4.11	4.36	4.68	4.18
Tb	0.62	0.63	0.57	0.62	0.67	0.67	0.65	0.70	0.75	0.67
Dy	4.04	4.27	3.57	3.91	4.31	4.35	4.16	4.45	4.72	4.29
Ho	0.82	0.86	0.73	0.77	0.88	0.87	0.85	0.89	0.98	0.88
Y	20.95	22.70	19.36	21.03	23.24	23.55	22.58	23.82	26.26	23.60
Er	2.31	2.43	2.10	2.35	2.56	2.47	2.43	2.66	2.74	2.49
Yb	2.28	2.32	2.01	2.18	2.44	2.37	2.29	2.58	2.62	2.45
Tm	0.32	0.35	0.29	0.31	0.35	0.35	0.35	0.37	0.41	0.36
Lu	0.33	0.36	0.29	0.32	0.36	0.37	0.35	0.37	0.41	0.35
Ni	40.1	40.8	47.5	29.2	46.0	26.9	48.8	20.4	38.6	22.1
Cu	71.6	51.1	67.1	34.8	55.3	33.4	80.5	27.8	101	26.5
Zn	60.8	109	71.9	74.5	120	87.0	83.3	94.3	158	88.5
Co	122	125	94.9	126	128	130	125	128	143	127

Table S3. Continuation *4*.

	Number									
	31	32	33	34	35	36	37	38	39	40
	N sample									
	2012	2012/1	2012/2	2012/3	2012/4	2012/5	2026/1	2026/5	2026/6	2027
	Formation									
Component	nd	nd	nd	nd	nd	nd	nd	mr	mr	mr
SiO_2	52.06	52.93	54.11	52.01	52.15	51.33	52.14	50.71	50.99	49.99
TiO_2	1.02	0.98	1.02	1.11	1.18	1.15	1.17	1.13	1.10	0.91
Al_2O_3	15.74	15.75	15.34	16.38	15.22	15.33	14.92	15.58	15.09	15.79
FeO	9.86	10.10	9.57	10.32	10.80	10.91	10.80	10.82	10.50	10.65
MnO	0.15	0.14	0.18	0.20	0.20	0.20	0.18	0.20	0.20	0.17
MgO	6.58	6.63	6.55	6.29	6.23	7.13	6.66	6.57	6.70	6.27
CaO	10.58	10.04	10.74	10.36	11.06	11.66	7.49	11.20	11.07	11.73
Na_2O	2.41	2.01	2.06	2.29	2.21	1.97	1.07	0.70	0.63	0.74
K_2O	1.04	0.71	1.01	1.01	0.76	0.56	4.57	2.68	2.71	2.58
P_2O_5	0.09	0.09	0.10	0.14	0.17	0.13	0.12	0.13	0.12	0.14
Total	99.5	99.4	100.7	100.1	100.0	100.4	99.1	99.7	99.1	98.9
Rb	27.45	16.93	37.33	33.53	14.61	15.16	48.91	20.13	16.56	11.17
Ba	342	348	324	310	256	181	182	220	191	291
Th	3.73	3.40	3.90	3.43	2.79	2.10	2.48	2.04	1.93	2.16
U	1.00	0.98	1.03	0.96	1.04	0.71	0.91	0.61	0.55	0.97
Nb	9.53	8.16	7.77	8.73	7.74	6.11	7.65	6.21	5.90	7.19
Ta	0.60	0.50	0.50	0.58	0.48	0.37	0.45	0.37	0.36	0.39
La	18.0	16.6	18.6	18.2	15.5	12.0	16.0	11.8	11.6	15.1
Ce	36.9	34.5	37.1	36.5	32.2	25.6	31.2	24.9	24.1	29.9
Pb	3.20	4.15	6.80	5.90	4.20	2.90	0.85	1.25	0.98	1.43
Pr	4.54	4.27	4.54	4.48	4.14	3.36	3.75	3.16	2.96	3.64
Nd	19.0	17.6	18.7	18.8	18.0	14.8	16.0	13.8	13.4	15.2
Sr	328	284	256	280	246	216	461	285	285	297
Sm	4.09	3.88	4.02	4.23	4.28	3.62	3.72	3.27	3.29	3.36
Zr	131	133	142	143	141	114	115	97.9	92.6	100
Hf	3.46	3.29	3.71	3.69	3.52	2.91	2.86	2.40	2.36	2.36
Eu	1.12	1.09	1.13	1.18	1.26	1.11	1.26	1.22	1.14	1.12
Ti	6465	5786	5435	6504	7499	6760	7147	6862	6787	5665
Gd	4.23	4.09	4.32	4.61	4.96	4.28	4.01	3.71	3.56	3.62
Tb	0.67	0.66	0.70	0.72	0.81	0.72	0.69	0.64	0.61	0.64
Dy	4.36	4.27	4.43	4.72	5.40	4.67	4.66	4.32	4.11	4.52
Ho	0.88	0.85	0.91	0.95	1.12	0.95	0.97	0.90	0.86	0.97
Y	23.26	23.21	24.25	25.46	30.29	26.33	23.86	22.03	21.44	23.73
Er	2.57	2.49	2.54	2.74	3.30	2.75	2.61	2.37	2.23	2.66
Yb	2.49	2.31	2.50	2.62	3.18	2.73	2.72	2.39	2.23	2.78
Tm	0.36	0.35	0.37	0.39	0.48	0.39	0.39	0.33	0.34	0.41
Lu	0.36	0.36	0.38	0.39	0.50	0.40	0.38	0.33	0.32	0.38
Ni	21.1	47.6	51.5	75.4	61.4	101	56.9	103	101	82.1
Cu	21.6	79.9	83.9	98.9	74.2	127	21.0	125	120	112
Zn	70.0	129	119	100	112	102	79.4	112	80.9	83.9
Co	131	133	142	143	141	114	115	97.9	92.6	100

Table S3. End.

	Number									
	41	42	43	44	45	46	47	48	49	50
	N sample									
	2029	2030.2	2031	2036	2037	2101/1	2101/2	2101/3	2101/5	2014/1
	Formation									
Component	mr	mr	mr	mr	mr	sill	sill	sill	sill	sill
SiO_2	49.20	50.67	51.07	51.16	52.16	49.07	42.78	48.57	44.57	49.78
TiO_2	0.99	1.08	1.20	0.59	0.63	1.15	2.81	1.82	2.32	1.01
Al_2O_3	15.23	15.81	16.30	11.75	12.48	16.34	4.31	15.58	13.00	15.40
FeO	10.87	11.22	11.68	10.47	8.20	12.51	25.58	16.39	20.43	10.35
MnO	0.17	0.22	0.19	0.19	0.16	0.18	0.34	0.19	0.26	0.17
MgO	9.32	7.56	8.39	14.7	10.5	6.60	11.0	4.55	6.13	9.50
CaO	10.23	11.38	7.26	9.59	13.86	11.56	12.66	9.41	10.56	10.96
Na_2O	1.63	1.99	2.29	1.13	1.39	2.22	0.53	2.80	2.07	1.75
K_2O	2.15	0.39	1.59	0.69	0.43	0.27	0.11	0.40	0.21	0.48
P_2O_5	0.15	0.11	0.09	0.06	0.07	0.01	0.05	0.12	0.08	0.11
Total	99.9	100.4	100.1	100.3	99.9	99.9	100.1	99.8	99.6	99.5
Rb	122	10.84	22.53	19.25	6.92	6.07	2.83	14.68	3.90	8.08
Ba	155	121	477	179	166	134	44.8	228	149	188
Th	1.68	1.32	1.43	1.94	1.97	0.08	1.02	2.34	1.05	1.35
U	0.44	0.47	0.72	0.44	0.42	0.04	0.30	0.37	0.32	0.35
Nb	4.71	4.33	5.54	4.49	4.74	0.47	2.21	3.74	2.09	4.78
Ta	0.30	0.27	0.31	0.28	0.27	0.77	0.48	0.17	0.16	0.15
La	11.6	7.92	7.56	10.7	11.0	2.00	6.17	11.9	6.26	8.69
Ce	23.0	17.8	17.6	22.0	22.8	4.37	14.9	23.1	13.3	18.5
Pb	1.57	2.77	2.40	2.12	2.81	2.19	2.15	1.56	4.85	2.13
Pr	2.96	2.39	2.52	2.75	2.88	0.60	2.21	2.89	1.82	2.43
Nd	13.3	11.3	12.2	11.5	12.2	3.10	10.9	12.1	8.40	11.0
Sr	161	190	268	202	184	300	44.4	278	241	266
Sm	3.19	3.04	3.41	2.57	2.73	0.88	3.10	2.60	2.12	2.85
Zr	90.8	88.4	96.8	78.9	75.5	6.8	37.4	30.0	29.1	81.3
Hf	2.40	2.33	2.56	2.05	2.00	0.29	1.21	0.98	0.89	2.16
Eu	1.06	1.04	1.13	0.74	0.83	0.51	0.81	1.00	0.84	1.01
Ti	6174	6618	7088	3559	3852	6586	16771	11994	13909	5855
Gd	3.78	3.76	4.06	2.75	2.89	1.06	3.56	2.78	2.36	3.28
Tb	0.62	0.63	0.68	0.45	0.45	0.17	0.56	0.40	0.36	0.53
Dy	4.13	4.31	4.59	2.90	2.95	1.15	3.73	2.53	2.39	3.52
Ho	0.85	0.89	0.96	0.58	0.58	0.24	0.78	0.51	0.48	0.71
Y	23.07	23.56	25.95	15.55	15.33	6.22	19.63	13.66	12.55	18.83
Er	2.50	2.64	2.76	1.64	1.71	0.71	2.23	1.49	1.36	2.05
Yb	2.43	2.44	2.64	1.58	1.62	0.68	2.06	1.32	1.27	1.98
Tm	0.35	0.38	0.38	0.24	0.23	0.10	0.31	0.20	0.19	0.29
Lu	0.35	0.39	0.41	0.24	0.24	0.11	0.32	0.20	0.19	0.29
Ni	105	139	125	182	59.7	89.5	133	56.4	216	153
Cu?	61.3	118	126	31.9	25.9	21.4	258	197	553	104
Zn	116	100	115	80.8	68.3	86.0	186	112	126	77.8
Co	90.8	88.4	96.8	78.9	75.5	6.82	37.4	30.0	29.1	81.3

Note. Oxides are given in wt.%, elements – in ppm. Formations: mr - Morongovsky, nd - Nadezhdinsky, hk - Khakanchansky, gd_2 – Gudchikhinsky (middle subformation), sv – Syverminsky. sill – gabbro-dolerite; bas – basalt, pbas-picrobasalt.