Supplementary materials

S1 The geochemical data of volcanic rocks from the middle Okinawa Trough

Rock type	Type 1 rhyolites							
Sample	C3-1-170	HD-13B	Z5-10	12-1YK	12-2YK	13-1YK	13-3YK	CB6-20
SiO_2(%)	70.61	75.39	71.69	70.16	72.11	70.64	67.72	75.04
TiO_2(%)	0.304	0.173	0.253	0.35	0.35	0.36	0.54	0.27
Al_2O_3(%)	13.09	12.97	12.95	13.73	14.44	14.09	15.41	13.9
FeO^T(%)	2.196	1.341	2.097	2.322	2.412	2.268	3.51	1.98
MnO(%)	0.065	0.057	0.063	0.13	0.07	0.06	0.1	0.06
MgO(%)	0.43	0.24	0.5	0.62	0.51	0.64	0.92	0.4
CaO(%)	2.03	1.4	2.07	2.12	2.2	2.14	3.04	1.86
Na_2O(%)	3.82	3.98	3.75	4.61	4.15	4.51	4.29	4.29
K_2O(%)	2.58	2.54	2.5	2.65	2.67	2.5	2.23	2.88
P_2O_5(%)	0.058	0.021	0.049	0.06	0.07	0.06	0.14	0.04
LOI(%)	4.58	1.88	3.83	2.73	2.18	2.33	1.87	2.72
Rb(ppm)	61.95	71.28	56.92	83.8	82.1	81.6	67.6	89.9
Sr(ppm)	111.92	98.5	112.96	125	125	128	166	105
Zr(ppm)	142.33	171.22	130.11	244	177	244	194	167
Nb(ppm)	5.98	8.89	5.72	6.5	6.6	6.3	7	6.5
Ba(ppm)	370.36	444.33	375.33	421	396	407	352	419
Hf(ppm)	3.77	3.83	3.89	5.13	4.29	5.15	4.44	4.13
Ta(ppm)	0.48	0.46	0.53	0.58	0.6	0.58	0.56	0.61
Pb(ppm)	7.78	6.51	7.78	9.1	6.68	6.95	5.97	6.83
Th(ppm)	5.9	5.05	6.26	7.51	7.08	7.23	5.87	7.62
U(ppm)	1.43	1.09	1.64	1.86	1.72	1.8	1.44	1.83
La(ppm)	15.68	20.33	15.01	17.27	16.2	16.78	16.37	16.25
Ce(ppm)	31.68	36.84	29.56	35.04	32.46	33.8	34.49	32.43
Pr(ppm)	3.59	4.12	3.27	3.87	3.75	3.79	4.08	3.64
Nd(ppm)	13.24	16.41	11.45	14.42	14.22	14.16	16.2	13.57
Sm(ppm)	2.97	2.95	2.47	3.07	3.08	3.07	3.71	2.9
Eu(ppm)	0.77	0.66	0.69	0.78	0.81	0.78	1.05	0.72
Gd(ppm)	3.3	3.23	2.33	3.06	3.09	3.05	3.78	2.89
Tb(ppm)	0.49	0.5	0.42	0.52	0.53	0.52	0.64	0.49
Dy(ppm)	3.45	3.62	2.59	3.28	3.33	3.31	4.02	3.14
Ho(ppm)	0.69	0.75	0.58	0.72	0.73	0.73	0.87	0.69
Er(ppm)	2.41	2.37	1.73	2.27	2.26	2.28	2.68	2.16
Tm(ppm)	0.4	0.44	0.3	0.38	0.38	0.38	0.43	0.36
Yb(ppm)	2.58	2.98	2.06	2.62	2.51	2.62	2.87	2.41
Lu(ppm)	0.39	0.45	0.33	0.42	0.41	0.42	0.46	0.39
$^{87}Sr/^{86}Sr$	0.704539	0.704255	0.704287	0.704292	0.704018	\	0.704056	0.704049
$^{143}Nd/^{144}Nd$	0.512729	0.512896	0.512865	0.512837	0.512863	\	0.512837	0.512856
Reference	Huang et al., 2006			Shinjo and Kato, 2000				

S1 (*continued*)

Rock type	Type 1 rhyolites		Type 2 rhyolites					
Sample	CB6-25	CB6-25M	D425-4	11-1YK	84-D1AP	88-DR8-1	88-DR7	84-D1BP
SiO_2(%)	72.38	70.93	71.11	68.8	73.07	70.51	77.4	72.82
TiO_2(%)	0.36	0.35	0.27	0.32	0.15	0.41	0.19	0.15
Al_2O_3(%)	14.32	14.37	13.93	14.81	13.09	14.54	13.35	12.88
FeO^T(%)	2.79	2.727	2.898	3.789	1.953	3.537	2.349	1.989
MnO(%)	0.07	0.06	0.11	0.15	0.08	0.11	0.08	0.09
MgO(%)	0.59	0.44	0.36	0.34	0.14	0.58	0.19	0.19
CaO(%)	2.33	2.21	2.06	2.36	1.28	2.39	1.37	1.31
Na_2O(%)	4.11	4.09	4.48	5.55	4.76	4.6	4.9	4.85
K_2O(%)	2.6	2.59	2.14	1.96	2.4	2.76	2.42	2.45
P_2O_5(%)	0.07	0.07	0.06	0.06	0.01	0.1	0.02	0.01
LOI(%)	1.55	1.86	1.97	1.41	2.81	2.87	0.16	2.99
Rb(ppm)	79.9	83.7	54.1	50.8	60.6	41.7	54.7	60.9
Sr(ppm)	125	128	141	146	71	134	67	72
Zr(ppm)	233	245	187	276	193	283	257	192
Nb(ppm)	6.1	6.6	5.7	8.7	8.6	9.3	9.6	8.6
Ba(ppm)	393	418	398	434	408	377	381	410
Hf(ppm)	5.13	5.29	4.79	6.45	4.82	6.66	6.38	4.84
Ta(ppm)	0.54	0.58	0.45	0.58	0.65	0.72	0.71	0.66
Pb(ppm)	6.96	6.83	9.3	10.74	8.22	8.5	6.49	8.31
Th(ppm)	7.2	7.48	5.57	6.04	6.13	5.84	6.04	6.16
U(ppm)	1.82	1.88	1.58	1.4	1.49	1.41	1.47	1.5
La(ppm)	16.57	17.33	18.89	25.56	21.86	22.02	22.88	21.9
Ce(ppm)	32.98	34.68	39.51	56.52	47.45	48.72	51.78	47.52
Pr(ppm)	3.75	3.93	4.77	6.94	5.62	6.07	6.49	5.63
Nd(ppm)	14.09	14.68	19.21	28.29	21.97	25.03	26.71	22.13
Sm(ppm)	3.04	3.14	4.5	6.7	5.12	6.02	6.58	5.16
Eu(ppm)	0.78	0.8	1.12	1.52	0.91	1.44	1.1	0.92
Gd(ppm)	3.03	3.09	4.71	6.9	5.27	6.24	6.81	5.29
Tb(ppm)	0.52	0.53	0.83	1.2	0.92	1.08	1.22	0.93
Dy(ppm)	3.3	3.33	5.27	7.75	5.99	6.95	8.02	6.04
Ho(ppm)	0.73	0.74	1.16	1.71	1.31	1.52	1.77	1.32
Er(ppm)	2.29	2.32	3.59	5.24	4.07	4.62	5.44	4.11
Tm(ppm)	0.38	0.39	0.58	0.84	0.66	0.75	0.88	0.67
Yb(ppm)	2.61	2.64	3.9	5.52	4.45	4.9	5.82	4.48
Lu(ppm)	0.43	0.43	0.61	0.87	0.71	0.77	0.91	0.72
$^{87}Sr/^{86}Sr$	0.704077	\	0.70476	0.704884	0.704474	0.704336	0.704351	\
$^{143}Nd/^{144}Nd$	0.512819	\	0.512801	0.512764	0.51281	0.51284	0.512831	\
Reference	Shinjo and Kato, 2000		Shinjo and Kato, 2000					

S1 (*continued*)

Rock type	Type 2 rhyolites		Type 3 rhyolites				Andesites	
Sample	88-DR8-2	88-DR8-3	E26	H-5W	84-D3P	Z7-3	24-56	24-46
SiO_2(%)	71.01	71.06	72.93	70.59	73.78	71.37	58.43	58.84
TiO_2(%)	0.36	0.36	0.181	0.268	0.19	0.377	0.85	0.76
Al_2O_3(%)	14.32	14.8	12.61	13.21	13.03	14.07	15.61	15.56
FeO^T(%)	3.366	2.952	2.214	3.078	2.304	3.312	6.624	6.678
MnO(%)	0.1	0.07	0.085	0.13	0.1	0.112	0.14	0.14
MgO(%)	0.44	0.42	0.23	0.58	0.28	0.42	4.19	3.97
CaO(%)	2.13	2.11	1.95	2.49	2.09	2.6	6.81	6.75
Na_2O(%)	4.98	5.19	4.15	4.06	4.78	4.65	3.9	3.97
K_2O(%)	2.51	2.38	1.82	1.45	1.31	1.78	1.3	1.5
P_2O_5(%)	0.07	0.07	0.023	0.024	0.01	0.044	0.2	0.21
LOI(%)	3.2	0.19	3.07	3.35	2.01	0.93	\	\
Rb(ppm)	48.6	70.3	41.82	34.03	35.8	48.88	29.2	31.6
Sr(ppm)	122	125	117.58	91.64	110	91.6	224.3	228.1
Zr(ppm)	295	296	136.81	124.61	171	187.65	141	157.9
Nb(ppm)	9.1	9.2	4.76	5.26	4.5	8.94	5.5	5.1
Ba(ppm)	385	392	276.93	213.15	259	209.94	215.6	253.9
Hf(ppm)	6.64	6.73	4.47	4.36	4.42	6.31		\
Ta(ppm)	0.63	0.66	0.31	0.48	0.33	0.8		\
Pb(ppm)	7.6	4.8	7.35	8.54	7.59	11.38		\
Th(ppm)	5.82	5.96	4.63	3.87	3.15	5.53		\
U(ppm)	1.45	1.6	1.19	1.01	0.95	1.12		\
La(ppm)	22.14	22.71	14.25	12.49	14.02	14.6		\
Ce(ppm)	49.21	50.38	31.94	29.15	32.01	34.23		\
Pr(ppm)	6.05	6.2	4.07	3.85	4.19	4.62		\
Nd(ppm)	24.69	25.17	16.8	16.24	18.12	19.73		\
Sm(ppm)	5.87	6	4.26	4.44	4.83	5.48		\
Eu(ppm)	1.35	1.4	0.98	1.03	1.03	1.59		\
Gd(ppm)	6.1	6.15	4.8	5.43	5.41	6.78		\
Tb(ppm)	1.06	1.06	0.85	0.94	0.97	1.25		\
Dy(ppm)	6.81	6.87	5.53	6.3	6.49	8.03		\
Ho(ppm)	1.49	1.5	1.29	1.43	1.45	1.86		\
Er(ppm)	4.58	4.56	3.89	4.3	4.49	5.42		\
Tm(ppm)	0.74	0.73	0.63	0.7	0.72	0.88		\
Yb(ppm)	4.83	4.82	4.38	4.63	4.8	5.74		\
Lu(ppm)	0.77	0.75	0.66	0.7	0.77	0.86		\
$^{87}Sr/^{86}Sr$			0.704319	0.705435	0.70448	0.705362		\
$^{143}Nd/^{144}Nd$			0.51286	0.512809	0.512872	0.512812		\
Reference	Shinjo and Kato, 2000		Huang et al., 2006				Ishizuka et al., 1990	

S1 (*continued*)

Rock type	Andesites								
Sample	Z13-5	DR8-1T	DR8-2T	DR8-3T	287-2A	287-2B	287-2C	CB6-24	JCD-2
SiO_2(%)	66.14	58.34	56.62	56.59	58.56	58.16	56.9	59.61	62.21
TiO_2(%)	0.331	1.32	1.35	1.4	1.29	1.29	1.3	0.87	1.07
Al_2O_3(%)	16.62	15.26	15.74	15.34	16.1	16.03	16.09	15.87	15.13
FeO^T(%)	3.303	7.173	8.01	8.577	8.748	8.811	8.991	7.578	5.499
MnO(%)	0.065	0.18	0.18	0.19	0.19	0.19	0.19	0.15	0.15
MgO(%)	1.24	2.97	3.12	3.06	3.41	3.48	3.35	4.36	1.73
CaO(%)	6.44	6.77	6.91	6.98	7.05	7.1	6.91	6.97	4.37
Na_2O(%)	3.16	3.88	3.91	3.87	3.91	3.89	3.85	3.4	4.99
K_2O(%)	0.86	1.04	0.98	1.05	1.1	1.08	1.02	1.24	1.79
P_2O_5(%)	0.031	0.09	0.12	0.11	0.38	0.38	0.37	0.21	0.31
LOI(%)	1.35	\	\	\	1.08	1.1	0.95	0.88	1.83
Rb(ppm)	25.2	\	\	\	26.7	25.5	26	34.5	48.1
Sr(ppm)	142.79	\	\	\	291	284	285	226	189
Zr(ppm)	49.87	\	\	\	148	143	146	149	246
Nb(ppm)	3.46	\	\	\	6.7	6.5	6.6	5.1	10
Ba(ppm)	129.59	\	\	\	197	190	193	206	282
Hf(ppm)	1.86	\	\	\	3.56	3.43	3.47	3.41	5.77
Ta(ppm)	0.28	\	\	\	0.44	0.43	0.42	0.37	0.68
Pb(ppm)	5.75	\	\	\	3.54	3.34	3.39	3.93	6.83
Th(ppm)	2.7	\	\	\	2.77	2.6	2.59	3.1	5.08
U(ppm)	0.58	\	\	\	0.72	0.66	0.64	0.81	1.23
La(ppm)	8.02	\	\	\	15.16	14.78	15.02	11.68	20.29
Ce(ppm)	18.17	\	\	\	35.1	34.18	34.57	26.07	46.18
Pr(ppm)	2.22	\	\	\	4.74	4.62	4.69	3.39	6.05
Nd(ppm)	9.48	\	\	\	21.18	20.63	20.89	14.69	25.75
Sm(ppm)	2.36	\	\	\	5.37	5.26	5.31	3.71	6.22
Eu(ppm)	0.95	\	\	\	1.77	1.73	1.75	1.21	1.75
Gd(ppm)	3.17	\	\	\	5.82	5.66	5.8	3.95	6.57
Tb(ppm)	0.53	\	\	\	0.98	0.96	0.97	0.68	1.12
Dy(ppm)	3.36	\	\	\	6.08	5.96	6.03	4.3	6.98
Ho(ppm)	0.76	\	\	\	1.31	1.27	1.29	0.93	1.53
Er(ppm)	2.17	\	\	\	3.8	3.74	3.77	2.78	4.57
Tm(ppm)	0.31	\	\	\	0.59	0.57	0.58	0.43	0.71
Yb(ppm)	2.16	\	\	\	3.68	3.61	3.67	2.81	4.66
Lu(ppm)	0.31	\	\	\	0.57	0.56	0.57	0.45	0.72
$^{87}Sr/^{86}Sr$	0.705698	\	\	\	0.704252	\	0.70427	0.704042	\
$^{143}Nd/^{144}Nd$	0.512634	\	\	\	0.512806	\	\	0.512829	\
Reference	Huang et al., 2006	Ishikawa et al., 1991			Shinjo and Kato, 2000				

S1 (*continued*)

Rock type	Basalts							
Sample	A-1-b	A-2-a	A-6	B-1-a	23-12	24-26	24-36	CB6-22-22
SiO_2(%)	49.74	49.68	51.9	51.45	49.56	49.63	49.98	50.18
TiO_2(%)	0.97	0.99	1.16	1.1	0.98	0.97	0.98	1
Al_2O_3(%)	16.11	15.93	16.67	16.71	16.15	16.24	16.22	16.34
FeO^T(%)	8.631	9.027	9.504	8.433	8.784	9.009	9.018	8.847
MnO(%)	0.17	0.18	0.2	0.18	0.16	0.16	0.16	0.16
MgO(%)	7.72	7.32	5.84	6.01	8.59	8.21	7.97	7.67
CaO(%)	11.91	12.21	10.46	10.79	11.93	11.78	11.8	11.91
Na_2O(%)	2.31	2.6	3.18	3.06	2.28	2.2	2.24	2.35
K_2O(%)	0.44	0.42	0.42	0.53	0.44	0.4	0.47	0.47
P_2O_5(%)	0.15	0.22	0.19	0.19	0.16	0.16	0.17	0.17
LOI(%)	\	\	\	\	\	\	\	\
Rb(ppm)	12	12.4	12	16.6	9.3	7.9	8.7	8.4
Sr(ppm)	289.3	291.9	293.2	296.4	245.9	250.6	253.2	249.2
Zr(ppm)	67.6	71.1	121.3	126.4	61	60.6	69.7	62.3
Nb(ppm)	\	\	\	\	2.3	2.5	2.8	3
Ba(ppm)	\	\	\	\	76.4	74.4	84.8	81.2
Hf(ppm)	\	\	\	\	\	\	\	\
Ta(ppm)	\	\	\	\	\	\	\	\
Pb(ppm)	\	\	\	\	\	\	\	\
Th(ppm)	\	\	\	\	\	\	\	\
U(ppm)	\	\	\	\	\	\	\	\
La(ppm)	\	\	\	\	\	\	\	\
Ce(ppm)	\	\	\	\	\	\	\	\
Pr(ppm)	\	\	\	\	\	\	\	\
Nd(ppm)	9	9.5	13.9	14.2	\	\	\	\
Sm(ppm)	2.6	2.7	3.7	3.7	\	\	\	\
Eu(ppm)	\	\	\	\	\	\	\	\
Gd(ppm)	\	\	\	\	\	\	\	\
Tb(ppm)	\	\	\	\	\	\	\	\
Dy(ppm)	\	\	\	\	\	\	\	\
Ho(ppm)	\	\	\	\	\	\	\	\
Er(ppm)	\	\	\	\	\	\	\	\
Tm(ppm)	\	\	\	\	\	\	\	\
Yb(ppm)	\	\	\	\	\	\	\	\
Lu(ppm)	\	\	\	\	\	\	\	\
$^{87}Sr/^{86}Sr$	0.70441±2	0.70440±3	0.70444±3	0.70489±2	\	\	\	\
$^{143}Nd/^{144}Nd$	0.51288±2	0.51286±3	0.51284±3	0.51277±2	\	\	\	\
Reference	Honma et al., 1991				Ishizuka et al., 1990			

S1 (*continued*)

Rock type	Basalts							
Sample	A-1-a	A-1-b*	A-2-b	A-6*	A-7-b	B-1-a*	B-1-b	CB6-22
SiO_2(%)	50.85	48.74	50.93	51.92	51.1	51.73	52.66	49.2
TiO_2(%)	1.05	0.92	1.01	1.16	1.38	1.08	1.1	0.96
Al_2O_3(%)	16.68	16.07	16.26	16.96	16.8	17.32	17.82	16.82
FeO^T(%)	8.892	8.721	9.045	9.504	9.099	8.55	7.974	8.721
MnO(%)	0.16	0.16	0.17	0.18	0.19	0.17	0.17	0.16
MgO(%)	6.7	8.06	8.38	6.32	5.34	6.42	5.47	7.68
CaO(%)	12.06	11.69	11.72	10.18	9.63	10.47	10.75	11.33
Na_2O(%)	2.19	2.06	2.13	2.65	3.36	2.58	2.67	2.15
K_2O(%)	0.47	0.43	0.42	0.44	0.6	0.54	0.55	0.42
P_2O_5(%)	0.18	0.16	0.17	0.24	0.24	0.2	0.2	0.16
LOI(%)	0.48	0.9	0.47	1.43	1.07	0.55	0.72	0.56
Rb(ppm)	9.1	8	7.9	8.3	14	13.3	13.6	8.8
Sr(ppm)	244	240	240	242	324	258	261	249
Zr(ppm)	58	53	56	93	85	93	96	58
Nb(ppm)	3.6	3.2	3.4	4.1	4	4.2	4.2	3.5
Ba(ppm)	75	69	72	95	114	107	109	75
Hf(ppm)	1.47	1.35	1.4	2.15	2.06	2.26	2.3	1.48
Ta(ppm)	0.24	0.21	0.23	0.25	0.26	0.29	0.27	0.23
Pb(ppm)	1.44	1.35	1.54	2.32	3.06	3.42	3.49	1.51
Th(ppm)	0.61	0.55	0.58	0.77	1.06	1.32	1.35	0.67
U(ppm)	0.31	0.2	0.18	0.2	0.29	0.6	0.34	0.21
La(ppm)	5.56	5.05	5.34	8.55	9.54	9.21	9.36	5.51
Ce(ppm)	13.29	12.08	12.73	20.59	22.43	21.8	22.26	13.22
Pr(ppm)	1.93	1.75	1.84	2.88	3.15	3.01	3.07	1.92
Nd(ppm)	9.16	8.42	8.77	13.25	14.39	13.63	13.88	9.2
Sm(ppm)	2.67	2.45	2.58	3.56	3.81	3.56	3.62	2.66
Eu(ppm)	1.03	0.96	0.99	1.25	1.36	1.21	1.24	1.03
Gd(ppm)	3.09	2.89	2.99	3.98	4.24	3.94	4.02	3.1
Tb(ppm)	0.54	0.5	0.52	0.68	0.72	0.67	0.68	0.54
Dy(ppm)	3.4	3.15	3.28	4.28	4.49	4.17	4.27	3.44
Ho(ppm)	0.73	0.68	0.7	0.92	0.96	0.89	0.91	0.73
Er(ppm)	2.09	1.96	2.05	2.69	2.78	2.61	2.68	2.11
Tm(ppm)	0.32	0.29	0.3	0.41	0.42	0.39	0.4	0.32
Yb(ppm)	1.97	1.85	1.9	2.56	2.64	2.5	2.56	1.97
Lu(ppm)	0.3	0.28	0.29	0.4	0.41	0.38	0.39	0.31
$^{87}Sr/^{86}Sr$	0.703937	0.703957	0.70395	0.704044	\	0.704489	0.70454	0.703892
$^{143}Nd/^{144}Nd$	0.512848	0.512862	0.512831	0.512827	\	0.512764	0.512714	0.51287
Reference	Shinjo et al., 1999							

S1 (*continued*)

Rock type	Basalts							
Sample	CB6-23	D-1YK	D-6AYK	D-6BYK	JCD-3	Basalt-13	Basalt-10	Basalt-11
SiO_2(%)	51.08	50.35	50.82	53.02	52.66	49.45	50.13	50.42
TiO_2(%)	0.99	1.08	1.06	1.14	1.13	0.99	0.97	1.1
Al_2O_3(%)	16.05	17.32	16.47	16.33	17.56	16.35	16.86	17.08
FeO^T(%)	9.108	8.748	8.514	9.639	8.496	9.144	9.27	9.477
MnO(%)	0.17	0.25	0.17	0.24	0.2	0.16	0.21	0.19
MgO(%)	8.62	6.03	6.24	6	6.01	9.1	5.95	6.28
CaO(%)	11.84	11.14	11.18	10.08	10.54	11.66	11.52	10.45
Na_2O(%)	2.11	2.52	2.84	2.74	2.68	2.37	2.53	2.73
K_2O(%)	0.42	0.35	0.5	0.5	0.56	0.49	0.68	0.45
P_2O_5(%)	0.17	0.26	0.17	0.19	0.21	0.16	0.23	0.3
LOI(%)	0.63	0.99	1.1	0.81	0.56	\	1.41	\
Rb(ppm)	8.6	7.1	13.1	11.7	14.3	\	15	13.7
Sr(ppm)	241	235	360	256	265	\	375	232
Zr(ppm)	55	62	69	90	100	\	124	65.1
Nb(ppm)	3.3	2.5	2.9	3.8	4.5	\	\	14.9
Ba(ppm)	71	76	87	102	118	\	79.9	101
Hf(ppm)	1.42	1.64	1.78	2.21	2.45	\	\	3
Ta(ppm)	0.23	0.17	0.28	0.25	0.3	\	0.229	\
Pb(ppm)	1.42	2.19	2.32	2.31	3.78	\	\	\
Th(ppm)	0.64	0.66	1.13	1.21	1.46	\	1.3	0.92
U(ppm)	0.2	0.21	0.31	0.32	0.37	\	0.768	0.43
La(ppm)	5.21	5.41	8.25	8.08	9.92	\	9.13	12.1
Ce(ppm)	12.54	13.59	19.02	19.16	23.34	\	20.5	25.7
Pr(ppm)	1.82	2.03	2.65	2.7	3.22	\	\	3.2
Nd(ppm)	8.73	9.84	11.98	12.49	14.57	\	12.7	13.9
Sm(ppm)	2.56	2.84	3.11	3.4	3.84	\	3.23	3.6
Eu(ppm)	0.99	1.05	1.15	1.23	1.29	\	1.18	1.2
Gd(ppm)	2.96	3.35	3.48	3.86	4.22	\	4.77	4.2
Tb(ppm)	0.52	0.58	0.6	0.67	0.72	\	0.653	0.67
Dy(ppm)	3.29	3.72	3.76	4.22	4.47	\	\	4.3
Ho(ppm)	0.7	0.81	0.81	0.91	0.96	\	\	0.9
Er(ppm)	2.03	2.35	2.4	2.65	2.81	\	\	2.8
Tm(ppm)	0.31	0.35	0.36	0.4	0.42	\	\	0.41
Yb(ppm)	1.9	2.25	2.28	2.55	2.7	\	2.13	2.5
Lu(ppm)	0.29	0.34	0.35	0.4	0.41	\	0.34	0.36
$^{87}Sr/^{86}Sr$	0.703862	0.704331	\	\	0.704311	\	\	\
$^{143}Nd/^{144}Nd$	\	0.512842	\	\	0.512709	\	\	\
Reference	Shinjo et al., 1999					Ma et al., 2004		

S1 (*continued*)

Rock type	Basalts							
Sample	Basalt-12	Basalt-1	Basalt-2	Basalt-8	Basalt-9	Basalt-14	Basalt-15	Basalt-16
SiO_2(%)	50.9	47.32	47.46	51.46	51.83	51.45	51.9	49.68
TiO_2(%)	1.09	0.85	0.84	1	0.99	1.1	1.16	0.99
Al_2O_3(%)	16.9	17.41	17.78	16.33	15.99	16.71	16.67	15.93
FeO^T(%)	9.54	9.828	9.567	9.198	9.225	8.433	9.504	9.027
MnO(%)	0.2	0.2	0.2	0.19	0.18	0.18	0.2	0.18
MgO(%)	6.48	8.93	7.05	7.09	7.32	6.01	5.84	7.32
CaO(%)	9.92	12.05	13.07	9.79	9.8	10.79	10.46	12.21
Na_2O(%)	2.49	1.97	2.1	2.76	2.69	3.06	3.18	2.6
K_2O(%)	0.4	0.54	0.52	0.42	0.42	0.53	0.42	0.42
P_2O_5(%)	0.33	0.19	0.18	0.2	0.19	0.19	0.19	0.22
LOI(%)	\	\	\	\	\	\	\	\
Rb(ppm)	14.6	23.7	9.62	7.8	7.8	\	\	\
Sr(ppm)	226	275	281	253	243	\	\	\
Zr(ppm)	71	58.5	60	55.2	68.9	\	\	\
Nb(ppm)	15	2.02	0.45	10.3	8.3	\	\	\
Ba(ppm)	99.1	\	\	75.8	71.8	\	\	\
Hf(ppm)	3	\	\	4.1	2.7	\	\	\
Ta(ppm)	\	\	\	\	\	\	\	\
Pb(ppm)	\	\	\	6.4	7.7	\	\	\
Th(ppm)	\	\	\	9.4	9.4	\	\	\
U(ppm)	\	\	\	0.14	0.14	\	\	\
La(ppm)	17.5	7.83	6.48	6.7	7.2	\	\	\
Ce(ppm)	22.9	13.9	13	14.6	16.1	\	\	\
Pr(ppm)	3.1	1.56	1.6	2.1	2.3	\	\	\
Nd(ppm)	14.1	6.76	6.21	10.1	10.9	\	\	\
Sm(ppm)	3.7	2.05	2.08	2.7	3.1	\	\	\
Eu(ppm)	1.2	0.709	0.701	0.93	1	\	\	\
Gd(ppm)	4.3	2.22	2.18	3.1	3.3	\	\	\
Tb(ppm)	0.67	0.402	0.38	0.55	0.6	\	\	\
Dy(ppm)	4.4	2.3	2.17	3.7	4.1	\	\	\
Ho(ppm)	0.92	0.482	0.476	0.82	0.9	\	\	\
Er(ppm)	2.6	1.23	1.2	2.3	2.5	\	\	\
Tm(ppm)	0.41	0.206	0.201	0.35	0.37	\	\	\
Yb(ppm)	2.5	1.22	1.2	2.2	2.3	\	\	\
Lu(ppm)	0.36	0.207	0.216	0.34	0.36	\	\	\
$^{87}Sr/^{86}Sr$	\	\	\	\	\	\	\	\
$^{143}Nd/^{144}Nd$	\	\	\	\	\	\	\	\
Reference	Ma et al., 2004							

S1 (*continued*)

Rock type	Basalts							
Sample	Basalt-17	Basalt-18	Basalt-19	Basalt-20	Basalt-21	Basalt-22	Basalt-23	Basalt-24
SiO_2(%)	49.74	51.56	51.65	52.08	53.14	53.2	53.21	51.62
TiO_2(%)	0.97	1.02	1.08	1.1	1.38	1.38	1.37	1.05
Al_2O_3(%)	16.11	16.61	17.14	17.72	17.57	17.66	17.57	16.98
FeO^T(%)	8.631	8.748	8.667	8.586	9.648	9.603	9.468	8.532
MnO(%)	0.17	0.17	0.17	0.18	0.18	0.18	0.17	0.2
MgO(%)	7.72	6.96	5.94	5.15	3.57	3.46	2.47	6.19
CaO(%)	11.91	10.49	10.64	10.27	8.88	8.89	8.89	10.8
Na_2O(%)	2.31	2.51	2.72	3.05	3.41	3.42	3.69	2.62
K_2O(%)	0.44	0.53	0.64	0.49	0.54	0.51	0.57	0.57
P_2O_5(%)	0.15	0.17	0.2	0.15	0.18	0.18	0.18	0.19
LOI(%)	\	0.39	0.4	0.56	0.68	0.54	0.48	0.25
Rb(ppm)	\	\	\	\	\	\	\	\
Sr(ppm)	\	\	\	\	\	\	\	\
Zr(ppm)	\	\	\	\	\	\	\	\
Nb(ppm)	\	\	\	\	\	\	\	\
Ba(ppm)	\	\	\	\	\	\	\	\
Hf(ppm)	\	\	\	\	\	\	\	\
Ta(ppm)	\	\	\	\	\	\	\	\
Pb(ppm)	\	\	\	\	\	\	\	\
Th(ppm)	\	\	\	\	\	\	\	\
U(ppm)	\	\	\	\	\	\	\	\
La(ppm)	\	\	\	\	\	\	\	\
Ce(ppm)	\	\	\	\	\	\	\	\
Pr(ppm)	\	\	\	\	\	\	\	\
Nd(ppm)	\	\	\	\	\	\	\	\
Sm(ppm)	\	\	\	\	\	\	\	\
Eu(ppm)	\	\	\	\	\	\	\	\
Gd(ppm)	\	\	\	\	\	\	\	\
Tb(ppm)	\	\	\	\	\	\	\	\
Dy(ppm)	\	\	\	\	\	\	\	\
Ho(ppm)	\	\	\	\	\	\	\	\
Er(ppm)	\	\	\	\	\	\	\	\
Tm(ppm)	\	\	\	\	\	\	\	\
Yb(ppm)	\	\	\	\	\	\	\	\
Lu(ppm)	\	\	\	\	\	\	\	\
$^{87}Sr/^{86}Sr$	\	\	\	\	\	\	\	\
$^{143}Nd/^{144}Nd$	\	\	\	\	\	\	\	\
Reference	Ma et al., 2004							

S2 Model compositions and partition coefficients of the average basalt, andesite, and rhyolite from the MOT

Phase	Rock type	wt.%	K_d(Nb)	K_d(Ta)	K_d(Sm)	K_d(Th)	K_d(Rb)	K_d(Nd)
	Basalt	0	\	\	\	\	\	\
Qtz	Andesite	10.47	0.008*	0.008*	0.014*	0.009*	0.014*	0.016*
	Rhyolite	29.91	0.008*	0.008	0.014	0.009	0.014	0.016
	Basalt	55.41	0.01	0.027	0.1	0.01	0.016	0.14
Plag	Andesite	55.79	0.027	0.03	0.07	0.01	0.039	0.09
	Rhyolite	49.15	0.07	0.05	0.12	0.01	0.06	0.19
	Basalt	2.91	0.01*	0.001*	0.04*	0.01*	0.11*	0.04*
Or	Andesite	7.07	0.01*	0.001*	0.04*	0.01*	0.11*	0.04*
	Rhyolite	14.5	0.01	0.015	0.04	0.02	0.31	0.04
	Basalt	17.12	0.004	0.011	0.4	0.014	0.011	0.382
Cpx	Andesite	8.04	0.3	0.43	0.954	0.03	0.03	0.645
	Rhyolite	0	\	\	\	\	\	\
	Basalt	17.94	0.0013	0.0025	0.039	0.0007	0.022	0.025
Opx	Andesite	16.04	0.01*	0.01*	0.028	0.05	0.022	0.028
	Rhyolite	5.6	0.165*	0.165	0.27	0.13	0.003	0.22
	Basalt	4.12	0.01	0.12	0.006	0.0001	0.01	0.008
Ol	Andesite	0	\	\	\	\	\	\
	Rhyolite	0	\	\	\	\	\	\
	Basalt	2.05	2.3	2.7	0.15	0.0012	0.1*	0.14
Il	Andesite	2.07	2.3	2.7	0.009	0.0012	0.1*	0.14*
	Rhyolite	0.6	6.58	3.167	0.684	0.427	0.1*	0.96
	Basalt	0.45	0.0035	0.0026	14.6	0.97	0.003	14
Ap	Andesite	0.52	0.0011	0.003	46	1.28	0.001	32.8
	Rhyolite	0.16	0.0012	0.0012	84.8	0.5	0.0013	61.2
	D_{Basalt}		0.0543278	0.0776272	0.2010728	0.0127481	0.0203721	0.214821
	$D_{Andesite}$		0.0899476	0.1097269	0.3639259	0.0243411	0.0390169	0.2845214
	$D_{Rhyolite}$		0.0869697	0.0573867	0.2238714	0.0211489	0.0793975	0.2199706

All Fe^{3+} are set to 0. Qtz, quartz; Pl, plagioclase; Or, orthoclase; Cpx, clinopyroxene; Opx, orthopyroxene; Ol, olivine; Il, ilmenite; Ap, apatite.

The values of K_d comes from partition coefficients database (http://earthref.org/GREM/) and Rollinson (1993).

*Estimated values

S3-1 Partition coefficients (K_d) used in Rayleigh fractionation and batch melting calculations

	Oliv^A	Cpx^A	Opx^A	Plag^A	Mt^A	Ap^A	Cpx^R	Opx^R	Amph^R	Pl^R	Mt^R	Ap^R
La	0.01	0.14	0.031	0.18	0.003	14.5	0.015	0.031	0.36	0.3	0.66	28.2
Ce	0.01	0.2	0.028	0.18	0.2	21.1	0.044	0.028	0.63	0.22	0.71	37.4
Nd	0.02	0.645	0.028	0.09	0.55	32.8	0.166	0.028	1.6	0.19	0.93	61.2
Sm	0.01	0.954	0.028	0.07	0.55	46	0.457	0.028	2.3	0.12	1.2	84.8
Eu	0.03	0.681	0.028	0.438	0.42	25.5	0.411	0.028	1.39	2.1	0.91	50.2
Gd	0.033	1.35	0.039	0.067	0.3	43.9	0.703	0.039	2	0.13	1	95.6
Dy	0.01	1.46	0.076	0.05	0.44	34.8	0.776	0.076	2.38	0.18	1.6	69.2
Er	0.026	1.33	0.153	0.045	0.3*	22.7	0.699	0.153	2.34	0.084	1	41.6
Yb	0.03	1.3	0.254	0.041	0.24	15.4	0.64	0.254	1.8	0.06	2.2	37
Rb	0.01	0.03	0.022	0.039	0.15	0.001	0.03	0.022	0.008	0.06	0.01	0.0013
Sr	0.02	0.033	0.032	1.31	0.11	4.3	0.17	0.032	0.9	4.4	0.01	2.43
Y	0.018	1	0.45	0.01	0.64	7.1	2.6	0.45	2.46	0.04	0.12	2.59
Zr	0.12	0.33	0.046	0.2	0.38	0.042	0.184	0.046	0.5	0.2	0.24	0.03
Nb	0.11	0.6*	0.01*	0.027	0.7	0.0011	0.6	0.01	0.98	0.07	0.05	0.0012
Ba	0.02	0.02	0.01	0.03	0.12	0.12	1.07	0.01	0.044	0.28	0.1	0.1
Hf	0.02	0.46	0.051	0.03	0.62	0.014	0.247	0.051	0.52	0.29	0.24	0.0065
Ta	0.01	0.43	0.01*	0.03	0.26	0.003	0.09	0.01	0.43	0.05	2.3	0.0012
Pb	0.01	0.87	0.01*	0.18	0.71	0.84	0.18	0.01	0.19	0.3	0.8	0.64
Th	0.02	0.03	0.05	0.01	0.05	1.28	1.9	0.05	0.16	0.01	0.01	0.5
U	0.04	0.04	0.05*	0.01	0.11*	1.4	1.01	0.05	0.16*	0.05	0.21	0.53

$^{A, R}$stand for partition coefficients (K_d) in andesitic and dacitic-rhyolitic melts. Ol, olivine; Cpx, clinopyroxene; Opx, orthopyroxene; Amph, amphibole; Pl, plagioclase; Mt, magnetite; Ap, apatite.

The values of K_d come from partition coefficients database (http://earthref.org/GREM/) and Rollinson (1993).

*Estimated values

S3-2 Compositions of minerals used in batch melting calculations

	Pl	Cpx	Opx	Amph	Mt	Il
SiO_2	56.67	50.45	54.41	44.03	0	0.18
TiO_2	0	0.63	0.23	2.18	15.6	50.81
Al_2O_3	26.8	4.28	1.37	9.46	1.05	0.11
FeO	0.33	5.85	14.51	15.71	82.12	45.6
MnO	0	0.19	0.42	0.24	1.18	0.43
MgO	0	16.06	26.92	12.13	0	2.55
CaO	9.72	21.25	1.81	10.96	0	0.18
Na_2O	5.93	0.25	0.04	1.69	0	0.02
K_2O	0.18	0	0	0.25	0	0
P_2O_5	0	0	0	0	0	0

Cpx, clinopyroxene; Opx, orthopyroxene; Amph, amphibole; Pl, plagioclase; Mt, magnetite; Il, ilmenite.

Reference: Shinjo and Kato, 2000

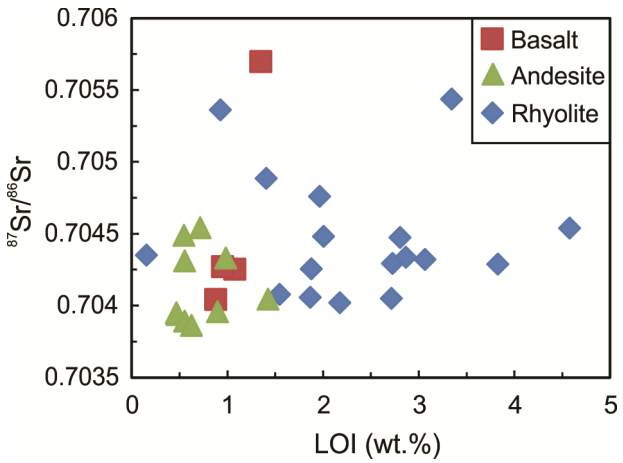

Fig. S4 Plots of $^{87}Sr/^{86}Sr$ versus LOI.