

SUPPLEMENTARY INFORMATION

Geochemical signals of high-temperature fluid–rock interactions in a mélange unit, Japan: Implications for geochemical reactions along major subduction-related faults

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Supplementary Table S1. Parameters used for modeling fluid–rock interactions.

Element	<i>D</i> values			<i>C</i> _{s0}	<i>C</i> _{f0}
	250 °C	300 °C	350 °C	(ppm)	(ppm)
Li	11	3.7	1.2	9.51	0.44
Rb	290	120	13	271	0.085
Sr	17	24	24	215	21
Cs	80	42	9.1	20.6	0.024
La	41000	41000	26000	47.2	0.0002
Sm	41000	47000	26000	8.40	0.0002
Pb	1900	350	110000	29.7	0.005

Supplementary Table S2. Major- and trace-element concentrations in PSZ samples and host rocks on both sides of the PSZ, and the concentrations expected for the PSZ in the absence of any fluid–rock interaction.

Element	Fault rock		Northern host rock			Southern host rock			Expected Value	
	PSZ_1	PSZ_2	N-HR_1	N-HR_2	N-HR_3	S-HR_1	S-HR_2	S-HR_3	PSZ_1	PSZ_2
Major elements (wt.%)										
SiO ₂	61.1	61.6	69.7	70.2	67.1	67.3	75.5	67.9	51.9	44.1
TiO ₂	1.25	1.59	0.670	0.570	0.600	0.530	0.380	0.620	0.956	1.13
Al ₂ O ₃	18.8	20.5	15.1	14.9	17.1	16.0	13.7	17.1	21.8	24.5
Fe ₂ O ₃	7.75	5.03	5.69	4.81	4.73	6.57	2.71	5.10	11.1	13.9
MnO	0.17	0.12	0.16	0.14	0.12	0.14	0.060	0.090	0.26	0.32
MgO	1.12	0.560	1.52	1.58	1.50	2.03	0.760	1.47	3.62	4.57
CaO	2.27	2.15	1.14	2.01	2.34	1.35	1.13	0.860	2.78	3.35
Na ₂ O	5.54	6.39	2.47	2.09	2.28	2.32	2.99	2.80	1.08	0.458
K ₂ O	1.78	1.72	3.48	3.64	4.19	3.73	2.66	3.90	6.39	7.62
P ₂ O ₅	0.24	0.27	0.12	0.10	0.090	0.10	0.080	0.12	0.14	0.16
Trace elements (ppm)										
Li	58.8	67.0	21.6	23.8	28.1	24.2	31.2	21.1	12.3	6.72
Be	1.72	1.59	1.96	2.20	2.45	2.41	1.46	2.05	4.11	5.00
P	892.0	1020	456.0	399.0	321.0	399.0	333.0	445.0	477.0	515.0
K	14110	13600	27410	29700	31510	30120	21390	28460	48140	56950
Sc	19.4	18.3	12.0	12.8	11.9	12.9	8.68	12.8	20.3	24.1
Ti	7170	8970	3790	3470	3320	3150	2210	3380	5419	6387
V	172	194	86.1	86.4	76.3	89.8	52.1	85.8	149	180
Cr	87.8	110	41.7	39.8	35.9	31.3	20.1	37.9	64.7	78.0
Mn	1220	836.0	1040	983.0	803.0	1050	481.0	647.0	1716	2105
Co	13.3	11.1	9.77	9.93	8.45	15.3	6.25	8.23	21.3	26.4
Ni	35.4	32.8	24.6	24.3	18.0	27.9	11.6	19.8	45.7	56.5
Cu	64.9	76.6	39.3	51.5	43.8	30.0	19.0	36.3	77.1	94.9
Zn	48.5	54.6	91.2	96.4	80.4	79.8	67.5	79.7	111	124
Ga	16.1	16.9	18.4	19.0	19.7	20.8	15.1	19.2	29.6	34.4

Rb	49.4	38.8	132	146	145	143	90.2	129	246	296
Sr	533	547	155	163	162	147	124	126	202	227
Y	30.4	33.2	22.4	21.7	22.7	23.5	17.1	21.9	34.2	39.7
Zr	175	191	118	106	111	107	77.7	105	168	196
Nb	16.1	19.0	9.24	9.69	10.3	10.5	7.26	9.80	16.1	19.0
Cs	1.77	1.42	6.54	7.93	8.54	9.91	4.19	7.56	18.2	23.0
Ba	316	326	202	246	363	239	217	229	403	470
La	29.0	28.0	30.1	29.5	30.8	29.3	21.8	25.0	43.7	50.7
Ce	54.5	52.8	55.9	57.3	60.9	57.1	43.1	51.6	86.4	100
Pr	7.35	7.40	7.07	6.96	7.08	6.84	5.07	6.13	10.3	12.0
Nd	29.6	30.4	26.9	26.4	26.5	26.4	19.2	23.0	39.1	45.5
Sm	6.75	7.20	5.45	5.21	5.35	5.16	3.85	4.75	7.78	9.03
Eu	1.81	1.99	1.14	1.05	1.11	0.980	0.790	0.920	1.49	1.70
Gd	6.60	7.30	5.14	4.89	5.03	5.04	3.66	4.45	7.44	8.65
Tb	1.00	1.13	0.722	0.715	0.752	0.729	0.545	0.685	1.09	1.27
Dy	6.41	6.87	4.34	4.26	4.52	4.62	3.22	4.20	7.00	8.23
Ho	1.27	1.33	0.882	0.878	0.883	0.915	0.626	0.848	1.42	1.67
Er	3.68	4.10	2.72	2.68	2.77	2.88	1.92	2.68	4.53	5.37
Tm	0.524	0.564	0.391	0.389	0.399	0.430	0.285	0.388	0.655	0.776
Yb	3.46	3.87	2.72	2.59	2.67	2.83	1.89	2.66	4.39	5.19
Lu	0.498	0.559	0.403	0.399	0.405	0.427	0.287	0.381	0.654	0.772
Hf	4.56	5.24	3.24	3.36	3.47	3.70	2.56	3.53	5.56	6.54
Ta	1.09	1.26	0.665	0.711	0.764	0.790	0.579	0.744	1.14	1.33
W	3.52	3.83	1.90	1.92	1.83	1.85	1.34	1.71	2.81	3.27
Pb	21.2	15.0	17.9	18.9	20.6	22.6	17.7	20.3	27.9	31.6
Th	10.5	10.5	9.97	10.9	11.6	12.6	9.08	11.5	17.5	20.4
U	2.25	2.16	1.99	2.13	2.39	2.53	1.87	2.42	3.53	4.10

Supplementary Table S3. Parameters used for modeling albitization.

Component	PSZ (average, wt.%)	Host Rock (average, wt.%)	F_E	C_{al}	C_{n-al}	p
Albite	50.8	21.2				
Major elements	(wt.%)	(wt.%)		(wt.%)	(wt.%)	
SiO ₂	61.35	69.60	0.88	50.02	69.35	0.581
TiO ₂	1.4	0.56	2.53	2.78	0.57	0.170
Al ₂ O ₃	19.68	15.65	1.26	26.01	15.68	0.376
Fe ₂ O ₃	6.39	4.94	1.29	7.60	5.06	0.400
MnO	0.15	0.12	1.23	0.15	0.12	0.441
MgO	0.840	1.48	0.57	-0.46	1.50	1.000
CaO	2.21	1.47	1.50	3.01	1.52	0.335
Na ₂ O	5.97	2.49	2.39	11.75	2.49	0.175
K ₂ O	1.8	3.6	0.49	-1.35	3.60	1.000
P ₂ O ₅	0.26	0.10	2.51	0.50	0.10	0.172
Trace elements	(ppm)	(ppm)		(ppm)	(ppm)	
Li	62.92	24.99	2.52	123.92	25.21	0.169
Be	1.65	2.09	0.79	0.74	2.11	0.740
P	954	392	2.43	1844	397	0.177
K	13855	28098	0.49	-10408	28157	1.000
Sc	18.86	11.84	1.59	28.71	12.03	0.295
Ti	8071	3220	2.51	15662.22	3270.03	0.173
V	183	79.4	2.31	341.03	80.94	0.192
Cr	98.8	34.5	2.87	198.74	35.17	0.150
Mn	1029	833.0	1.24	1118.47	857.51	0.434
Co	12.2	9.65	1.26	14.43	9.86	0.406
Ni	34.1	21.0	1.62	50.80	21.56	0.298
Cu	70.8	36.6	1.93	119.09	37.51	0.240
Zn	51.6	82.5	0.62	-0.93	82.60	1.000
Ga	16.5	18.7	0.88	12.23	18.75	0.605
Rb	44.1	131	0.34	-105.75	131.35	1.000

Sr	540	146	3.69	1138.90	151.84	0.118
Y	31.8	21.5	1.48	47.04	21.73	0.316
Zr	183	104	1.76	301.01	105.60	0.260
Nb	17.6	9.45	1.86	30.07	9.56	0.241
Cs	1.60	7.45	0.21	-8.56	7.49	0.000
Ba	321	249	1.29	415.21	251.90	0.378
La	28.5	27.8	1.03	27.06	28.04	0.509
Ce	53.6	54.3	0.99	48.09	54.77	0.532
Pr	7.37	6.53	1.13	8.16	6.59	0.447
Nd	30.0	24.7	1.21	36.28	24.98	0.408
Sm	6.97	4.96	1.41	9.79	5.01	0.339
Eu	1.90	1.00	1.90	3.24	1.01	0.238
Gd	6.96	4.70	1.48	10.22	4.75	0.317
Tb	1.07	0.690	1.54	1.63	0.70	0.300
Dy	6.64	4.19	1.58	10.22	4.24	0.293
Ho	1.30	0.840	1.55	1.97	0.85	0.301
Er	3.89	2.61	1.49	5.76	2.64	0.314
Tm	0.54	0.38	1.43	0.78	0.38	0.331
Yb	3.67	2.56	1.43	5.29	2.58	0.328
Lu	0.53	0.38	1.38	0.73	0.39	0.345
Hf	4.90	3.31	1.48	7.29	3.33	0.314
Ta	1.18	0.710	1.66	1.90	0.71	0.274
W	3.68	1.75	2.09	6.56	1.79	0.214
Pb	18.1	19.7	0.92	14.1	19.8	0.585
Th	10.5	10.9	0.96	9.29	10.98	0.542
U	2.21	2.22	0.99	2.10	2.23	0.515

Supplementary Table S4. Mineral assemblages

Component	Fault rock			Northern host rock			Southern host rock		
(wt.%)	PSZ_1	PSZ_2	Cat	N-HR_1	N-HR_2	N-HR_3	S-HR_1	S-HR_2	S-HR_3
Quartz	13.3	8.50	5.40	38.0	37.6	31.4	32.7	46.5	29.6
K-feldspar	1.9	5.8	0.0	0.60	0.0	1.6	0.60	0.70	1.2
Plagioclase	55.7	62.9	49.2	23.4	18.4	21.0	24.3	27.4	27.0
Carbonate minerals	3.6	0.90	4.5	3.7	4.5	5.4	5.0	2.5	2.7
Magnetic minerals	1.7	1.8	7.5	0.0	0.0	0.30	0.0	0.0	0.0
Pyrite	0.4	0.2	0.4	0.0	0.1	0.3	0.5	0.2	0.2
Total non-clay minerals	76.6	80.2	67.0	65.8	60.6	60.0	63.1	77.2	60.6
Halloysite	5.5	0.0	6.1	0.0	0.20	0.0	0.0	0.0	0.0
Kaolinite	2.1	3.8	3.1	1.6	0.0	0.50	0.0	0.0	0.30
Smectite	0.0	6.7	3.2	0.10	0.0	0.0	0.0	0.70	0.0
Illite	10.5	8.50	14.8	32.3	37.7	39.2	36.4	22.1	37.8
Chlorite	5.3	0.80	5.7	0.0	0.0	0.20	0.40	0.0	0.40
Muscovite	0.0	0.0	0.0	0.20	1.5	0.0	0.0	0.0	0.80
Total clay minerals	23.4	19.8	33.0	34.2	39.4	40.0	36.9	22.8	39.4