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Chemical data of locality averages of Ries outer suevite components: whole-rock, matrix, and melt particle

Preparation of suevite samples for geochemical data set:

Whole-rock analysis

Suevite samples from which only lithic and mineral clasts larger than approx. 1 cm have been removed.

Matrix analysis

Preparations as whole-rock but melt particles larger than approx. 1 cm were also removed.

Melt particle separates

3-10 larger melt particles of one suevite sample are mechanically removed and combined to one melt sample.

Analytical methods:

XRF analyses of suevite whole-rock and separated matrix from localities Aumühle and Alte Bürg were carried out by XRF with a BRUKER AXS S8 TIGER instrument at Museum für Naturkunde Berlin (for more informations see Raschke et al., 2013).

Separated melt particle and matrix (marked with *) were analyzed at ALS Geochemistry Canada Ltd. for major elements by ICP-AES, for the trace elements Ba, Ce, Cr, Cs, Dy, Er, Eu, Ga, Gd, Hf, Ho, La, Lu, Nb, Nd, Pr, Rb, Sm, Sn, Sr, Ta, Tb, Th, Tm, U, V, W, Y, Yb, Zr by ICP-MS, and for the trace elements As, Co, Cu, Li, Ni, Pb, Sc, Zn by ICP-AES.

LA-ICP-MS trace-element analyses were performed at the Institute of Mineralogy and Economic Geology, RWTH Aachen, Germany. The analyses were carried out using a 193 nm ArF excimer laser ablation system (UP193FX, New Wave Research, Inc.) coupled to an ICP-MS system (DRCe Quadrupol-MS, Perkin Elmer). The samples were ablated for 50 s at 4Hz repetition rate with 100 µm crater diameters, the irradiance was set to 0.8 GW/cm2. The reference material NIST 612 was used as an external calibration standard, Si was used as internal standard element for all Si melt analyses.

In-situ chemical analyses of major elements of melt particle were obtained at Museum für Naturkunde Berlin, Germany, using a JEOL Superprobe JXA-8500F electron microprobe (EMP). A cup current of 15 nA with an acceleration potential of 15 keV and an electron beam diameter of 3 µm were used for single spot or profile analyses.

Geochemical data of suevite melt particle (in-situ analyses): locality averages of outer suevite exposures

location	Aumühle	Doosweiher	Otting	Alte Bürg	Aufhausen	Bollstadt	Oberringingen	Zipplingen	d.l.
area	East	East	East	West	West	West	West	West	EMP
n sample	3 1σ	2 1σ	8 1σ	4 1σ	3 1σ	4 1σ	3 1σ	2 1σ	LA-ICP-MS
SiO2 (wt.%)	62.74 ± 0.59	63.53 ± 0.86	62.83 ± 1.16	62.39 ± 1.13	62.53 ± 1.16	63.05 ± 1.28	62.75 ± 0.16	63.79 ± 2.32	0.01
TiO2	0.71 ± 0.10	0.87 ± 0.08	0.83 ± 0.05	0.70 ± 0.01	0.75 ± 0.05	0.75 ± 0.03	0.80 ± 0.03	0.78 ± 0.13	0.02
Al2O3	15.65 ± 0.44	16.20 ± 0.56	16.43 ± 0.76	16.82 ± 0.32	16.49 ± 0.56	16.36 ± 0.38	16.68 ± 0.57	16.78 ± 0.86	0.01
Fe2O3	5.68 ± 0.15	5.04 ± 0.32	5.50 ± 0.30	5.17 ± 0.15	5.53 ± 0.40	5.43 ± 0.17	5.62 ± 0.30	5.67 ± 0.74	0.03
MnO	0.11 ± 0.01	0.10 ± 0.01	0.11 ± 0.01	0.09 ± 0.01	0.11 ± 0.01	0.12 ± 0.01	0.12 ± 0.01	0.11 ± 0.02	0.02
MgO	3.28 ± 0.31	2.50 ± 0.00	2.74 ± 0.16	2.54 ± 0.11	2.93 ± 0.19	2.94 ± 0.05	3.04 ± 0.36	2.78 ± 0.28	0.01
CaO	4.18 ± 0.31	3.01 ± 0.04	3.67 ± 0.15	4.15 ± 0.22	4.45 ± 0.23	4.16 ± 0.10	4.05 ± 0.49	4.06 ± 0.19	0.01
Na2O	2.16 ± 0.45	2.11 ± 0.07	2.61 ± 0.24	2.61 ± 0.27	3.13 ± 0.39	3.46 ± 0.22	2.56 ± 0.16	3.43 ± 0.18	0.01
K2O	4.44 ± 0.51	5.98 ± 0.18	4.37 ± 0.28	4.26 ± 0.67	3.46 ± 0.26	3.39 ± 0.16	4.34 ± 0.07	2.84 ± 0.08	0.01
P2O5	0.26 ± 0.02	0.32 ± 0.07	0.33 ± 0.02	0.28 ± 0.06	0.25 ± 0.05	0.25 ± 0.02	0.26 ± 0.03	0.21 ± 0.07	0.01
Total	99.19 ± 0.36	99.66 ± 0.33	99.42 ± 0.45	99.02 ± 0.61	99.64 ± 0.33	99.91 ± 0.66	99.51 ± 0.32	100.45 ± 0.11	
Ba (ppm)	1435 ± 357	1423 ± 113	1279 ± 108	987 ± 80	970 ± 146	1085 ± 97	1023 ± 20	959 ± 99	3
Ce	90.6 ± 2.8	95.0 ± 0.4	88.1 ± 9.5	70.3 ± 5.5	74.2 ± 4.6	77.3 ± 5.3	70.6 ± 1.0	70.1 ± 0.5	0.4
Co	8 ± 8	14 ± 2	14 ± 2	16 ± 1	15 ± 1	13 ± 1	14 ± 1	15 ± 1	7
Cr	119 ± 33	118 ± 24	104 ± 19	109 ± 33	114 ± 6	113 ± 2	108 ± 20	112 ± 28	65
Cs	23.7 ± 9.4	29.7 ± 6.7	13.5 ± 3.4	12.7 ± 3.9	9.9 ± 0.7	9.6 ± 0.8	11.8 ± 1.7	13.7 ± 0.3	0.6
Cu	n.d.	n.d.	14 ± 4	9 ± 4	17 ± 7	31 ± 19	n.d.	19 ± 4	7
Dy	4 ± 1	3 ± 1	4 ± 1	4 ± 1	4 ± 1	3 ± 1	3 ± 1	3 ± 1	1
Er	2.3 ± 0.4	1.6 ± 0.1	2.5 ± 0.7	2.6 ± 0.2	2.3 ± 0.2	2.0 ± 0.2	1.9 ± 0.1	1.9 ± 0.1	1.1
Eu	0.5 ± 0.5	1.2 ± 0.1	1.5 ± 0.2	1.2 ± 0.1	1.5 ± 0.1	1.4 ± 0.3	1.3 ± 0.2	1.3 ± 0.1	0.6
Ga	49 ± 6	43 ± 2	44 ± 5	50 ± 12	36 ± 4	37 ± 7	40 ± 5	38 ± 1	7
Gd	2 ± 2	5 ± 1	5 ± 1	6 ± 1	5 ± 1	4 ± 1	4 ± 1	5 ± 1	2
Hf	6 ± 1	5 ± 1	6 ± 1	5 ± 1	5 ± 1	5 ± 1	6 ± 1	5 ± 1	2
Ho	0.4 ± 0.4	0.8 ± 0.1	1.0 ± 0.1	1.1 ± 0.2	1.0 ± 0.1	0.8 ± 0.1	0.9 ± 0.1	0.9 ± 0.1	0.5
La	38.8 ± 3.1	37.1 ± 0.3	38.1 ± 3.8	30.3 ± 2.1	30.0 ± 2.8	32.4 ± 3.1	28.7 ± 1.8	30.2 ± 0.5	0.5
Lu	n.d.	0.4 ± 0.1	0.5 ± 0.1	0.6 ± 0.2	0.7 ± 0.2	0.4 ± 0.1	0.6 ± 0.1	0.5 ± 0.2	0.5
Nb	20 ± 3	17 ± 1	18 ± 2	14 ± 2	13 ± 1	13 ± 1	13 ± 1	12 ± 1	1
Nd	32 ± 2	37 ± 1	37 ± 3	29 ± 1	33 ± 2	32 ± 1	28 ± 1	28 ± 2	2
Ni	27 ± 8	24 ± 13	32 ± 6	28 ± 5	30 ± 4	16 ± 6	19 ± 3	21 ± 8	16
Pb	21.6 ± 8.9	31.3 ± 5.5	21.4 ± 6.2	28.7 ± 2.3	23.0 ± 2.5	22.9 ± 8.0	16.6 ± 6.4	225.5 ± 177.3	0.9
Pr	12.5 ± 0.6	12.6 ± 0.0	12.3 ± 1.2	9.7 ± 0.2	11.2 ± 0.7	10.9 ± 0.7	10.0 ± 0.2	9.9 ± 0.3	0.4
Rb	194 ± 41	261 ± 29	186 ± 19	173 ± 44	128 ± 8	128 ± 22	171 ± 26	117 ± 3	3
Sc	20 ± 7	19 ± 7	17 ± 2	19 ± 1	20 ± 4	19 ± 7	17 ± 2	18 ± 2	15
Sm	3 ± 3	7 ± 1	7 ± 1	6 ± 1	7 ± 1	6 ± 1	6 ± 1	5 ± 0	2
Sr	447 ± 85	243 ± 1	380 ± 33	393 ± 63	337 ± 44	347 ± 50	328 ± 38	385 ± 3	1
Ta	0.5 ± 0.5	0.8 ± 0.3	1.0 ± 0.2	1.2 ± 0.3	0.9 ± 0.2	0.9 ± 0.3	0.9 ± 0.1	0.7 ± 0.3	0.6
Tb	0.5 ± 0.5	0.8 ± 0.1	1.0 ± 0.2	1.0 ± 0.2	0.9 ± 0.1	0.8 ± 0.2	0.8 ± 0.2	0.8 ± 0.2	0.5
Th	7.6 ± 7.6	16.8 ± 0.2	17.9 ± 2.8	13.0 ± 1.7	12.6 ± 2.0	13.9 ± 1.1	13.3 ± 0.8	12.0 ± 0.2	0.4
Tm	0.3 ± 0.2	0.3 ± 0.2	0.4 ± 0.1	0.8 ± 0.2	0.5 ± 0.2	n.d.	0.5 ± 0.1	n.d.	0.5
U	5.5 ± 0.2	6.1 ± 0.2	5.6 ± 0.6	3.9 ± 0.7	3.9 ± 0.3	4.4 ± 0.2	4.7 ± 0.1	3.9 ± 0.2	0.3
V	121 ± 25	139 ± 19	134 ± 8	148 ± 6	151 ± 19	137 ± 6	132 ± 6	139 ± 25	6
W	7 ± 1	3 ± 1	4 ± 1	4 ± 1	4 ± 1	3 ± 1	4 ± 1	28 ± 25	2
Y	27 ± 2	20 ± 1	27 ± 3	26 ± 2	26 ± 1	22 ± 3	23 ± 2	25 ± 1	2
Yb	3 ± 1	2 ± 1	2 ± 1	3 ± 1	3 ± 1	3 ± 1	2 ± 1	3 ± 1	2
Zr	191 ± 15	208 ± 7	238 ± 39	190 ± 29	162 ± 63	170 ± 11	194 ± 17	174 ± 35	4

Geochemical data of separated suevite melt particle: locality averages of outer suevite exposures

location	Aumühle *	Doosweiher *	Otting	Alte Bürg *	Aufhausen	Bollstadt *	Oberringingen*	Zipplingen *	d.l.
area	East	East	East	West	West	West	West	West	ICP-AES
n sample	6 1σ	2 1σ	7 1σ	2 1σ	3 1σ	4 1σ	3 1σ	2 1σ	ICP-MS
SiO2 (wt.%)	65.23 ± 1.35	62.60 ± 0.50	61.67 ± 1.77	58.25 ± 1.15	60.70 ± 3.16	62.20 ± 2.45	62.73 ± 1.70	63.85 ± 1.65	0.01
TiO2	0.74 ± 0.08	0.86 ± 0.02	0.77 ± 0.03	0.68 ± 0.01	0.63 ± 0.02	0.68 ± 0.02	0.72 ± 0.06	0.69 ± 0.12	0.01
Al2O3	16.28 ± 0.66	16.58 ± 0.13	15.38 ± 0.60	14.35 ± 0.45	16.62 ± 1.18	16.30 ± 2.02	16.10 ± 1.10	15.95 ± 1.05	0.01
Fe2O3	3.33 ± 0.84	4.86 ± 0.03	4.85 ± 0.24	4.89 ± 0.33	4.65 ± 0.10	4.60 ± 0.25	4.78 ± 0.17	5.00 ± 0.58	0.01
MnO	0.07 ± 0.06	0.11 ± 0.03	0.09 ± 0.01	0.11 ± 0.03	0.11 ± 0.02	0.08 ± 0.00	0.09 ± 0.00	0.10 ± 0.02	0.01
MgO	0.96 ± 0.20	2.29 ± 0.19	2.47 ± 0.10	2.21 ± 0.03	2.70 ± 0.20	2.43 ± 0.16	2.74 ± 0.04	2.59 ± 0.19	0.01
CaO	3.27 ± 0.45	3.21 ± 0.04	4.03 ± 1.04	7.36 ± 1.10	4.53 ± 1.13	4.00 ± 0.65	3.62 ± 0.05	3.94 ± 0.18	0.01
Na2O	3.30 ± 0.68	2.34 ± 0.11	2.57 ± 0.24	2.88 ± 0.00	2.45 ± 0.31	2.98 ± 0.20	2.63 ± 0.13	3.28 ± 0.15	0.01
K2O	3.24 ± 0.50	4.21 ± 0.30	3.45 ± 0.36	2.73 ± 0.15	2.33 ± 0.33	2.48 ± 0.09	2.84 ± 0.25	2.40 ± 0.03	0.01
P2O5	0.29 ± 0.07	0.35 ± 0.02	0.33 ± 0.05	0.25 ± 0.04	0.23 ± 0.02	0.32 ± 0.14	0.26 ± 0.06	0.20 ± 0.06	0.01
LOI	3.03 ± 1.10	3.55 ± 0.11	4.12 ± 1.41	5.91 ± 0.09	5.41 ± 2.09	3.80 ± 0.96	3.91 ± 0.29	2.14 ± 0.27	0.01
Total	99.73 ± 0.53	100.93 ± 0.38	99.73 ± 0.32	99.60 ± 0.28	100.37 ± 0.16	99.86 ± 0.51	100.43 ± 0.56	100.12 ± 0.27	
As (ppm)	10 ± 3	8 ± 1	10 ± 1	7 ± 3	7 ± 1	8 ± 1	6 ± 1	25 ± 3	5
Ba	1168.0 ± 236.3	1677.5 ± 102.5	2594.4 ± 2485.9	804.0 ± 139.0	765.3 ± 88.8	1141.3 ± 143.3	1051.7 ± 153.9	859.5 ± 28.5	0.5
Ce	75.1 ± 17.7	108.0 ± 8.0	93.2 ± 6.5	65.5 ± 0.5	61.4 ± 3.5	68.8 ± 5.4	76.4 ± 5.6	63.7 ± 2.7	0.5
Co	10 ± 6	13 ± 1	11 ± 1	10 ± 1	11 ± 1	11 ± 1	12 ± 1	12 ± 1	1
Cr	100 ± 95	65 ± 5	66 ± 9	51 ± 9	63 ± 5	65 ± 5	70 ± 8	70 ± 30	10
Cs	15.91 ± 3.01	18.03 ± 2.38	13.77 ± 3.04	8.31 ± 0.01	7.49 ± 0.66	7.77 ± 0.99	8.21 ± 1.21	10.85 ± 1.11	0.01
Cu	22 ± 4	5 ± 2	13 ± 6	18 ± 7	15 ± 5	17 ± 2	12 ± 4	13 ± 8	1
Dy	4.53 ± 1.46	5.35 ± 0.02	4.57 ± 0.20	3.94 ± 0.03	4.07 ± 0.36	4.29 ± 0.21	4.69 ± 0.36	4.11 ± 0.49	0.05
Er	2.52 ± 0.70	2.82 ± 0.02	2.47 ± 0.09	2.20 ± 0.02	2.47 ± 0.10	2.32 ± 0.08	2.62 ± 0.20	2.43 ± 0.49	0.03
Eu	1.40 ± 0.42	1.77 ± 0.04	1.55 ± 0.10	1.20 ± 0.02	1.26 ± 0.12	1.33 ± 0.07	1.53 ± 0.16	1.33 ± 0.15	0.03
Ga	17.7 ± 1.3	20.9 ± 0.2	18.1 ± 1.5	17.8 ± 0.2	19.1 ± 1.2	19.8 ± 1.9	19.0 ± 0.9	18.4 ± 1.9	0.1
Gd	5.31 ± 1.76	6.95 ± 0.32	5.88 ± 0.55	5.06 ± 0.03	4.98 ± 0.38	5.08 ± 0.33	5.61 ± 0.71	5.01 ± 0.72	0.05
Hf	5.6 ± 0.6	8.1 ± 0.5	7.0 ± 0.3	5.5 ± 0.1	5.4 ± 0.4	6.3 ± 0.2	6.4 ± 0.3	5.5 ± 0.3	0.2
Ho	0.88 ± 0.26	1.02 ± 0.01	0.91 ± 0.04	0.81 ± 0.01	0.87 ± 0.06	0.86 ± 0.02	0.96 ± 0.09	0.88 ± 0.13	0.01
La	36.5 ± 9.5	54.1 ± 3.5	46.4 ± 3.5	34.7 ± 2.4	32.3 ± 2.4	34.8 ± 3.0	39.1 ± 3.3	32.7 ± 1.3	0.5
Li	18 ± 4	90 ± 10	53 ± 7	50 ± 5	57 ± 5	58 ± 4	50 ± 5	60 ± 5	10
Lu	0.37 ± 0.10	0.39 ± 0.01	0.36 ± 0.02	0.30 ± 0.01	0.34 ± 0.04	0.35 ± 0.01	0.37 ± 0.04	0.35 ± 0.08	0.01
Nb	11.0 ± 1.5	14.3 ± 0.5	12.5 ± 1.0	9.2 ± 0.1	9.0 ± 0.2	9.6 ± 0.6	11.0 ± 0.3	8.8 ± 1.0	0.2
Nd	36.5 ± 11.4	48.9 ± 2.9	43.4 ± 2.8	32.4 ± 0.1	30.8 ± 2.4	33.8 ± 2.7	38.8 ± 3.9	31.0 ± 2.1	0.1
Ni	23 ± 6	46 ± 3	25 ± 2	22 ± 5	24 ± 1	22 ± 4	35 ± 7	21 ± 6	1
Pb	26 ± 17	26 ± 1	28 ± 4	26 ± 7	31 ± 8	25 ± 5	22 ± 4	61 ± 20	2
Pr	8.91 ± 2.74	12.35 ± 0.65	10.85 ± 0.66	7.77 ± 0.02	7.90 ± 0.55	8.38 ± 0.81	9.21 ± 0.71	7.90 ± 0.31	0.03
Rb	155.7 ± 20.3	218.0 ± 14.0	147.8 ± 20.9	92.8 ± 12.8	101.1 ± 7.8	114.1 ± 3.4	115.5 ± 12.2	104.0 ± 0.1	0.2
Sc	10 ± 1	13 ± 1	12 ± 1	15 ± 2	12 ± 1	13 ± 1	13 ± 1	14 ± 2	1
Sm	7.24 ± 2.43	10.09 ± 0.31	8.19 ± 0.58	6.21 ± 0.02	6.23 ± 0.60	6.63 ± 0.46	7.52 ± 0.64	6.20 ± 0.72	0.03
Sn	16 ± 19	3 ± 1	5 ± 3	4 ± 1	4 ± 1	3 ± 1	3 ± 1	2 ± 1	1
Sr	415.7 ± 44.7	467.0 ± 55.0	370.7 ± 50.1	375.0 ± 0.1	285.3 ± 17.1	343.0 ± 54.6	326.7 ± 39.4	327.0 ± 1.0	0.1
Ta	0.7 ± 0.1	0.9 ± 0.1	0.8 ± 0.1	0.6 ± 0.1	0.6 ± 0.1	0.6 ± 0.1	0.7 ± 0.1	0.6 ± 0.1	0.1
Tb	0.77 ± 0.23	0.99 ± 0.02	0.85 ± 0.08	0.75 ± 0.01	0.74 ± 0.05	0.73 ± 0.03	0.84 ± 0.06	0.76 ± 0.11	0.01
Th	17.55 ± 3.09	24.95 ± 1.75	20.73 ± 2.17	14.30 ± 0.03	13.22 ± 1.55	15.55 ± 1.23	17.60 ± 1.70	12.23 ± 0.43	0.05
Tm	0.37 ± 0.10	0.39 ± 0.01	0.36 ± 0.03	0.34 ± 0.01	0.36 ± 0.04	0.34 ± 0.01	0.36 ± 0.04	0.37 ± 0.05	0.01
U	3.83 ± 1.08	5.67 ± 0.25	5.65 ± 0.71	3.87 ± 0.03	3.47 ± 0.14	4.32 ± 0.41	4.83 ± 0.66	3.90 ± 0.45	0.05
V	78 ± 7	92 ± 1	90 ± 5	101 ± 4	96 ± 6	95 ± 11	96 ± 7	108 ± 18	5
W	3 ± 1	3 ± 1	3 ± 1	2 ± 1	2 ± 1	3 ± 1	2 ± 1	5 ± 2	1
Y	26.6 ± 6.8	26.7 ± 0.5	23.3 ± 1.5	23.6 ± 2.4	22.9 ± 1.8	22.3 ± 0.9	25.5 ± 2.7	22.7 ± 2.3	0.5
Yb	2.34 ± 0.66	2.67 ± 0.15	2.41 ± 0.14	2.22 ± 0.02	2.26 ± 0.19	2.25 ± 0.03	2.61 ± 0.22	2.31 ± 0.37	0.03
Zn	79 ± 15	70 ± 1	62 ± 10	70 ± 1	76 ± 11	72 ± 9	63 ± 3	74 ± 42	2
Zr	200 ± 18	289 ± 16	241 ± 23	177 ± 8	189 ± 16	221 ± 5	225 ± 16	191 ± 10	2

Geochemical data of separated suevite matrix: locality averages of outer suevite exposures

location	Aumühle	Doosweiher *	Otting *	Alte Bürg	Aufhausen *	Bollstadt *	Oberringingen*	Zipplingen*	d.l.	d.l.
area	East	East	East	West	West	West	West	West	ICP-AES	XRF
n sample	5 1σ	2 1σ	7 1σ	2 1σ	3 1σ	4 1σ	3 1σ	2	ICP-MS	
SiO2 (wt.%)	65 ± 1	63.30 ± 0.50	61.36 ± 2.43	53 ± 1	60.50 ± 0.80	61.20 ± 1.29	63.93 ± 0.69	62.55 ± 2.15	0.01	1
TiO2	0.78 ± 0.02	0.73 ± 0.03	0.75 ± 0.06	0.58 ± 0.01	0.55 ± 0.02	0.54 ± 0.03	0.54 ± 0.02	0.53 ± 0.01	0.01	0.01
Al2O3	14.9 ± 0.4	15.00 ± 0.30	13.95 ± 0.62	12.4 ± 0.2	13.47 ± 0.26	13.45 ± 0.39	13.57 ± 0.34	13.75 ± 0.05	0.01	0.5
Fe2O3	4.88 ± 0.97	4.54 ± 0.41	4.93 ± 0.35	4.70 ± 0.17	4.46 ± 0.22	4.13 ± 0.03	4.08 ± 0.21	3.96 ± 0.08	0.01	0.05
MnO	0.1 ± 0.1	0.12 ± 0.09	0.06 ± 0.02	0.1 ± 0.1	0.11 ± 0.02	0.08 ± 0.03	0.06 ± 0.00	0.07 ± 0.01	0.01	0.1
MgO	0.9 ± 0.1	1.05 ± 0.02	2.56 ± 0.28	2.0 ± 0.1	3.26 ± 0.09	2.41 ± 0.18	2.35 ± 0.14	2.15 ± 0.02	0.01	0.1
CaO	3.2 ± 0.5	2.57 ± 0.07	3.85 ± 2.20	11.4 ± 0.7	3.50 ± 0.87	3.69 ± 0.96	2.64 ± 0.13	3.79 ± 0.90	0.01	0.1
Na2O	2.6 ± 0.3	2.33 ± 0.01	1.34 ± 0.08	1.8 ± 0.1	1.63 ± 0.05	1.53 ± 0.13	1.90 ± 0.03	2.37 ± 0.07	0.01	0.1
K2O	2.8 ± 0.2	3.64 ± 0.18	2.12 ± 0.14	1.3 ± 0.1	1.08 ± 0.06	1.43 ± 0.11	1.34 ± 0.05	2.62 ± 0.18	0.01	0.1
P2O5	0.2 ± 0.1	0.33 ± 0.02	0.30 ± 0.05	0.2 ± 0.1	0.21 ± 0.01	0.18 ± 0.02	0.18 ± 0.02	0.19 ± 0.01	0.01	0.1
LOI	4.4 ± 0.8	5.37 ± 0.35	8.34 ± 1.49	11.8 ± 0.1	11.17 ± 0.37	10.80 ± 0.88	8.81 ± 0.09	8.14 ± 0.58	0.01	0.1
Total	99.44 ± 0.15	99.18 ± 0.27	99.63 ± 0.56	99.27 ± 0.12	100.02 ± 0.20	99.62 ± 0.17	99.50 ± 0.66	100.23 ± 0.84		
As (ppm)	n.a.	9 ± 2	<5	n.a.	<5	7 ± 3	6 ± 1	9 ± 1	5	
Ba	992 ± 56	1530.0 ± 15.0	1100.7 ± 214.9	427 ± 72	578.3 ± 127.2	1435.0 ± 232.2	668.7 ± 14.4	807.0 ± 8.0	0.5	10
Ce	78 ± 6	106.00 ± 0.25	97.49 ± 6.06	59 ± 1	64.40 ± 2.97	66.23 ± 2.68	72.60 ± 2.71	77.60 ± 2.10	0.50	10
Co	13 ± 3	13.0 ± 2.0	10.6 ± 0.7	11 ± 1	10.3 ± 1.7	11.0 ± 1.2	11.0 ± 0.8	9.5 ± 0.5	1.0	5
Cr	74 ± 5	75 ± 5	66 ± 11	45 ± 1	67 ± 5	68 ± 8	63 ± 5	55 ± 5	10	5
Cs	n.a.	14.30 ± 0.75	11.40 ± 0.65	n.a.	5.69 ± 0.39	7.60 ± 0.63	3.93 ± 0.27	24.15 ± 1.75	0.01	
Cu	39 ± 2	17 ± 1	27 ± 5	31 ± 8	22 ± 1	21 ± 1	20 ± 1	23 ± 2	1	15
Dy	n.a.	4.39 ± 0.03	4.27 ± 0.16	n.a.	4.56 ± 1.39	3.76 ± 0.18	4.40 ± 0.77	3.64 ± 0.27	0.05	
Er	n.a.	2.34 ± 0.02	2.23 ± 0.03	n.a.	2.74 ± 0.72	2.23 ± 0.15	2.57 ± 0.52	1.97 ± 0.15	0.03	
Eu	n.a.	1.71 ± 0.02	1.41 ± 0.08	n.a.	1.47 ± 0.44	1.24 ± 0.06	1.31 ± 0.22	1.14 ± 0.07	0.03	
Ga	19 ± 1	20.7 ± 0.1	17.6 ± 0.7	15 ± 8	17.6 ± 0.7	17.3 ± 0.6	17.2 ± 0.2	18.6 ± 0.4	0.1	15
Gd	n.a.	6.12 ± 0.01	5.43 ± 0.36	n.a.	5.72 ± 1.73	4.74 ± 0.14	5.36 ± 0.92	4.31 ± 0.11	0.05	
Hf	n.a.	7.2 ± 0.1	6.4 ± 0.5	n.a.	5.2 ± 0.2	5.3 ± 0.3	5.6 ± 0.4	5.8 ± 0.4	0.2	
Ho	n.a.	0.83 ± 0.03	0.80 ± 0.01	n.a.	0.94 ± 0.26	0.79 ± 0.06	0.90 ± 0.17	0.72 ± 0.06	0.01	
La	38 ± 5	52.1 ± 0.6	48.0 ± 6.2	35 ± 5	38.0 ± 6.1	32.4 ± 1.9	38.2 ± 7.3	34.8 ± 0.6	0.5	10
Li	n.a.	40 ± 5	35 ± 5	n.a.	87 ± 5	70 ± 7	80 ± 5	45 ± 5	10	
Lu	n.a.	0.34 ± 0.02	0.32 ± 0.01	n.a.	0.41 ± 0.11	0.34 ± 0.03	0.37 ± 0.05	0.28 ± 0.03	0.01	
Nb	12 ± 1	14.5 ± 0.1	13.5 ± 0.8	<10	9.0 ± 0.7	8.8 ± 0.7	9.2 ± 0.2	8.8 ± 0.2	0.2	10
Nd	<5	46.9 ± 1.0	39.1 ± 2.5	<5	36.5 ± 9.8	30.9 ± 1.8	33.6 ± 5.0	29.3 ± 0.3	0.1	5
Ni	41 ± 5	31 ± 9	30 ± 3	29 ± 4	25 ± 2	21 ± 3	20 ± 3	19 ± 2	1	
Pb	54 ± 4	27 ± 1	47 ± 4	22 ± 8	31 ± 3	39 ± 4	72 ± 8	43 ± 6	2	15
Pr	n.a.	12.20 ± 0.20	10.09 ± 0.67	n.a.	9.27 ± 2.27	7.87 ± 0.48	8.73 ± 1.18	7.92 ± 0.16	0.03	
Rb	98 ± 20	139.0 ± 1.5	98.2 ± 11.4	49 ± 7	46.2 ± 1.6	72.4 ± 5.8	42.9 ± 1.6	145.5 ± 10.0	0.2	5
Sc	17 ± 4	11 ± 1	14 ± 2	15 ± 1	12 ± 1	12 ± 1	11 ± 1	11 ± 1	1	5
Sm	n.a.	8.29 ± 0.17	7.52 ± 0.61	n.a.	6.82 ± 2.09	5.64 ± 0.32	6.45 ± 1.14	5.75 ± 0.13	0.03	
Sn	n.a.	3 ± 1	3 ± 1	n.a.	4 ± 1	4 ± 1	3 ± 1	5 ± 1	1	
Sr	315 ± 14	415.5 ± 5.5	243.1 ± 20.6	282 ± 2	213.7 ± 3.3	255.0 ± 24.4	251.3 ± 2.9	310.5 ± 22.5	0.1	5
Ta	n.a.	0.8 ± 0.1	0.9 ± 0.1	n.a.	0.5 ± 0.1	0.5 ± 0.1	0.6 ± 0.1	0.6 ± 0.1	0.1	
Tb	n.a.	0.82 ± 0.03	0.78 ± 0.02	n.a.	0.83 ± 0.26	0.67 ± 0.04	0.80 ± 0.13	0.65 ± 0.04	0.01	
Th	15 ± 1	23.55 ± 1.05	18.74 ± 3.05	<15	13.33 ± 0.87	13.56 ± 0.80	17.72 ± 2.69	16.03 ± 1.03	0.05	15
Tm	n.a.	0.34 ± 0.01	0.33 ± 0.01	n.a.	0.38 ± 0.11	0.32 ± 0.02	0.39 ± 0.07	0.31 ± 0.03	0.01	
U	n.a.	3.57 ± 0.14	4.95 ± 0.04	n.a.	3.21 ± 0.51	2.65 ± 0.22	4.00 ± 1.39	3.33 ± 0.36	0.05	
V	114 ± 7	91 ± 2	93 ± 5	102 ± 5	88 ± 3	79 ± 7	82 ± 5	90 ± 2	5	5
W	n.a.	3 ± 1	3 ± 1	n.a.	2 ± 1	2 ± 1	2 ± 1	5 ± 1	1	
Y	25.6 ± 1.6	24.0 ± 0.2	23.3 ± 1.3	20.5 ± 2.5	28.1 ± 7.8	22.3 ± 2.2	28.6 ± 7.6	19.8 ± 2.1	0.5	10
Yb	n.a.	2.26 ± 0.10	2.07 ± 0.01	n.a.	2.63 ± 0.77	2.19 ± 0.15	2.39 ± 0.35	1.92 ± 0.17	0.03	
Zn	104 ± 12	83 ± 11	76 ± 3	75 ± 3	83 ± 1	98 ± 7	109 ± 7	71 ± 4	2	15
Zr	195 ± 5	281 ± 7	229 ± 25	145 ± 4	197 ± 7	199 ± 9	220 ± 20	236 ± 12	2	10

Geochemical data of suevite whole-rock: locality averages of outer suevite exposures

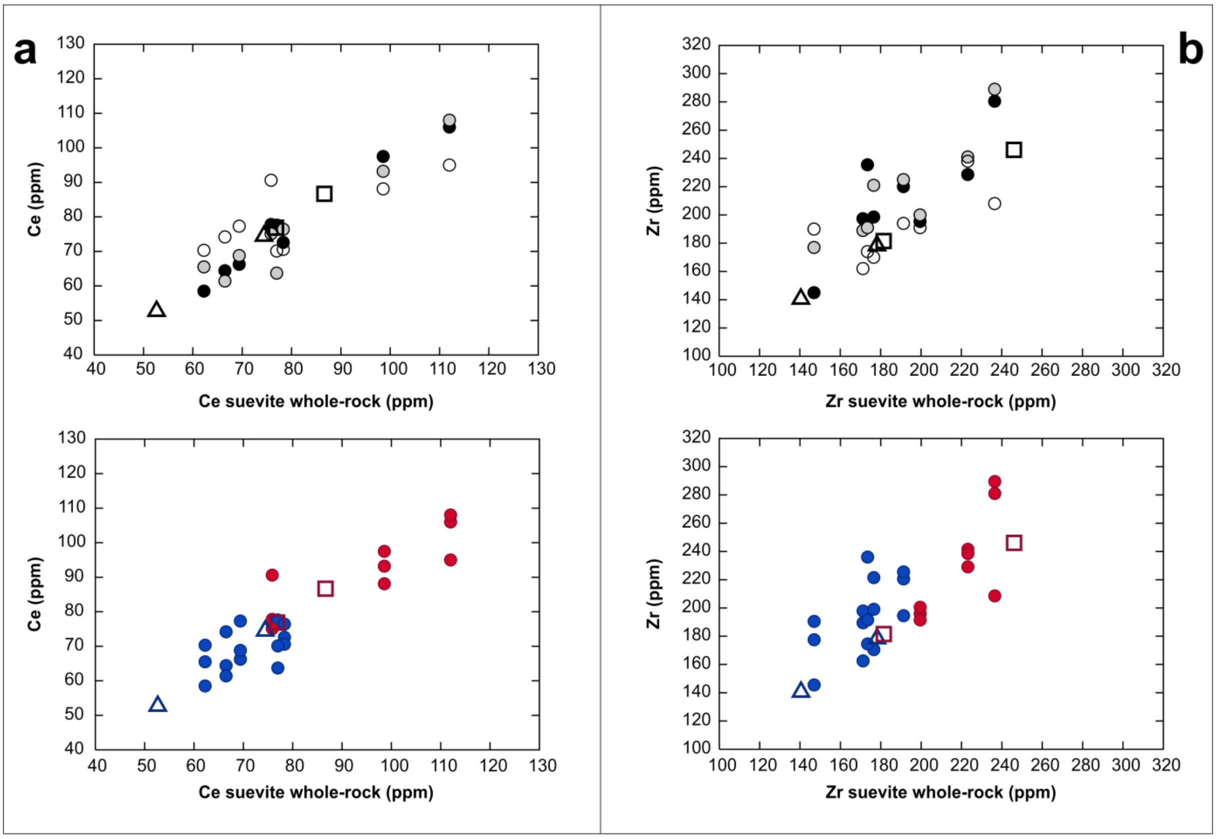
location	Aumühle	Doosweiher	Otting	Alte Bürg	Aufhausen	Bollstadt	Oberringingen	Zipplingen	d.l.
area	East	East	East	West	West	West	West	West	XRF
n sample	7 1σ	2 1σ	12 1σ	4 1σ	4 1σ	5 1σ	3 1σ	2 1σ	
SiO2 (wt.%)	65 ± 1	64 ± 1	62 ± 3	53 ± 3	60 ± 4	64 ± 1	65 ± 1	61 ± 1	1
TiO2	0.78 ± 0.03	0.85 ± 0.01	0.80 ± 0.03	0.60 ± 0.05	0.64 ± 0.03	0.63 ± 0.03	0.66 ± 0.01	0.63 ± 0.01	0.01
Al2O3	15.1 ± 0.5	15.6 ± 0.1	14.2 ± 0.7	12.7 ± 0.8	13.5 ± 0.8	14.3 ± 0.3	14.3 ± 0.1	14.4 ± 0.3	0.5
Fe2O3	4.15 ± 0.68	5.16 ± 0.43	5.04 ± 0.29	4.42 ± 0.34	4.93 ± 0.23	4.53 ± 0.32	4.91 ± 0.22	4.57 ± 0.05	0.05
MnO	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.1
MgO	0.9 ± 0.1	1.1 ± 0.1	2.5 ± 0.3	1.9 ± 0.1	3.4 ± 0.2	2.4 ± 0.1	2.6 ± 0.1	2.2 ± 0.1	0.1
CaO	3.5 ± 1.2	2.8 ± 0.1	4.4 ± 2.4	11.0 ± 1.9	5.9 ± 2.8	3.5 ± 0.4	3.1 ± 0.1	5.1 ± 1.2	0.1
Na2O	2.5 ± 0.2	2.6 ± 0.1	1.5 ± 0.2	1.8 ± 0.2	2.0 ± 0.1	1.7 ± 0.3	2.1 ± 0.1	2.5 ± 0.1	0.1
K2O	2.8 ± 0.4	4.0 ± 0.3	2.4 ± 0.2	1.4 ± 0.1	1.5 ± 0.2	1.6 ± 0.2	1.5 ± 0.1	2.8 ± 0.1	0.1
P2O5	0.2 ± 0.1	0.3 ± 0.1	0.3 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.1
LOI	4.4 ± 0.5	3.1 ± 0.2	6.5 ± 1.8	11.8 ± 1.8	6.8 ± 1.9	6.3 ± 0.6	4.9 ± 0.1	6.0 ± 0.7	0.1
Total	98.55 ± 1.96	99.59 ± 0.06	97.14 ± 2.94	94.06 ± 5.66	99.41 ± 0.26	99.45 ± 0.31	99.47 ± 0.58	99.56 ± 0.28	
Ba (ppm)	997 ± 243	1451 ± 34	1120 ± 171	614 ± 273	829 ± 496	1367 ± 467	964 ± 316	695 ± 8	10
Ce	76 ± 6	112 ± 4	99 ± 6	62 ± 4	67 ± 4	69 ± 6	78 ± 8	77 ± 2	10
Co	12 ± 6	13 ± 4	10 ± 1	9 ± 1	9 ± 2	9 ± 1	11 ± 1	9 ± 1	5
Cr	72 ± 6	52 ± 3	57 ± 3	45 ± 3	53 ± 3	45 ± 3	51 ± 3	41 ± 5	5
Cu	34 ± 2	29 ± 1	29 ± 2	30 ± 2	28 ± 1	27 ± 1	29 ± 1	31 ± 2	15
Ga	19 ± 1	20 ± 8	18 ± 1	17 ± 1	16 ± 1	16 ± 1	17 ± 1	18 ± 1	15
La	37 ± 3	50 ± 2	48 ± 6	27 ± 4	40 ± 6	36 ± 11	35 ± 1	43 ± 6	10
Nb	11 ± 5	14 ± 5	14 ± 1	<10	10 ± 5	10 ± 5	11 ± 1	<10	10
Ni	38 ± 6	34 ± 7	33 ± 3	24 ± 4	26 ± 2	26 ± 4	30 ± 4	25 ± 3	5
Pb	47 ± 2	24 ± 6	46 ± 6	21 ± 1	30 ± 3	44 ± 13	58 ± 12	42 ± 3	15
Rb	111 ± 15	136 ± 1	102 ± 8	58 ± 5	51 ± 7	63 ± 15	63 ± 36	124 ± 5	5
Sc	17 ± 1	15 ± 2	15 ± 1	16 ± 1	16 ± 2	16 ± 1	15 ± 2	14 ± 2	5
Sr	317 ± 10	408 ± 5	247 ± 18	332 ± 99	217 ± 21	218 ± 23	245 ± 14	291 ± 21	5
Th	15 ± 8	17 ± 2	18 ± 2	<15	<15	<15	16 ± 8	<15	15
V	113 ± 13	85 ± 1	88 ± 2	101 ± 2	86 ± 2	74 ± 3	80 ± 1	84 ± 3	5
Y	25 ± 2	27 ± 3	25 ± 1	21 ± 2	26 ± 2	26 ± 7	24 ± 2	22 ± 2	10
Zn	116 ± 29	83 ± 15	74 ± 5	70 ± 7	77 ± 5	90 ± 3	85 ± 13	70 ± 1	15
Zr	200 ± 5	237 ± 6	223 ± 11	147 ± 11	171 ± 6	177 ± 9	191 ± 10	174 ± 2	10

n.a.= not analyzed

DR2

Ce and Zr whole-rock vs. suevite components diagrams

The composition of suevite melts (two methods) and matrix component is plotted vs. the whole-rock composition. For drill cores Nördlingen FBN 73 and Enkingen SUBO 18 (data from Reimold et al., 2013) only whole-rock data are plotted.



Outer suevite

○ melt (laser ablation ICP-MS)

● separated melt (XRF/ICP-MS)

● separated matrix (XRF)

□ ● eastern area

△ ● western area

Crater suevite (drill cores)

△ Nördlingen FBN 73 suevite whole rock bottom and top part* (XRF)

□ Enkingen SUBO 18 suevite whole rock bottom and top part (XRF)

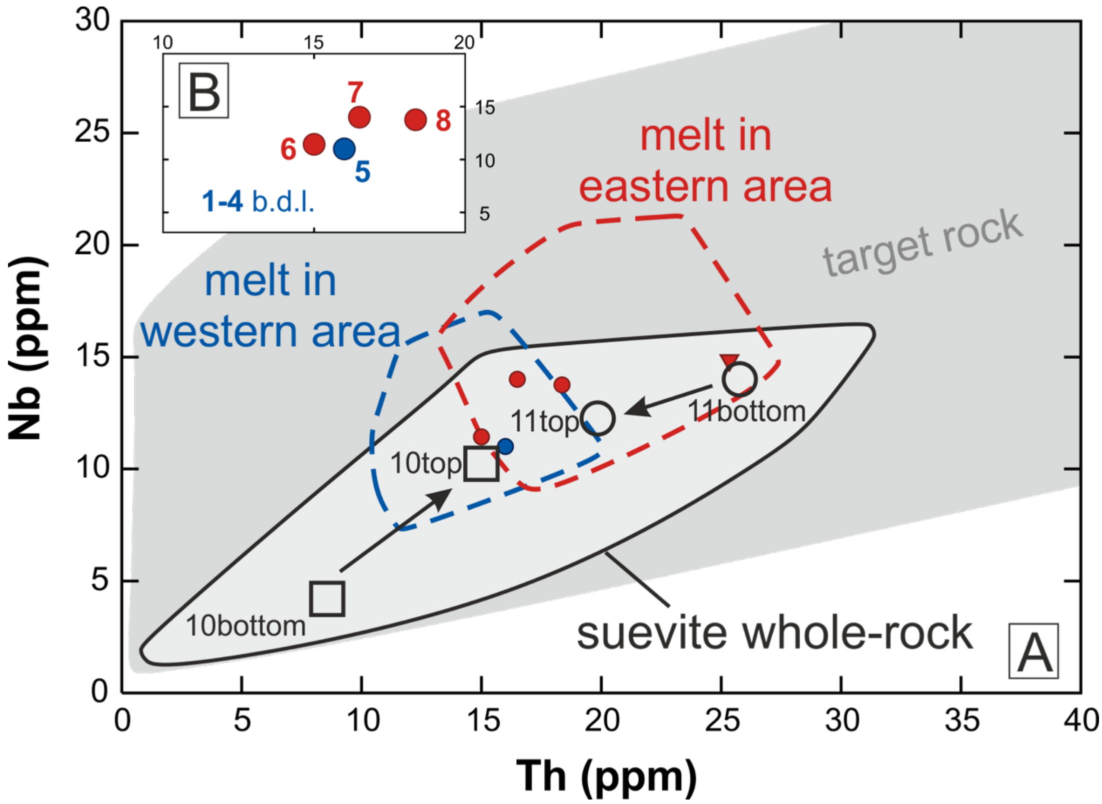
* subdivision after Pohl et al. (1977), and Stöffler (1977)

a) top diagram: Ce (suevite whole-rock) vs. Ce (suevite components)
bottom diagram: data grouped in western (blue) and eastern (red) part of Ries impact crater structure
b) top diagram: Zr (suevite whole-rock) vs. Zr (suevite components)
bottom diagram: data grouped in western (blue) and eastern (red) part of Ries impact crater structure

Melt particles, matrix, and whole-rock data of outer suevite exhibit similar 'immobile' trace element composition at each individual location with an overall positive Ce and Zr correlation. Drill core data (triangle, square) follow the same compositional trend as the other suevite locations.

DR3

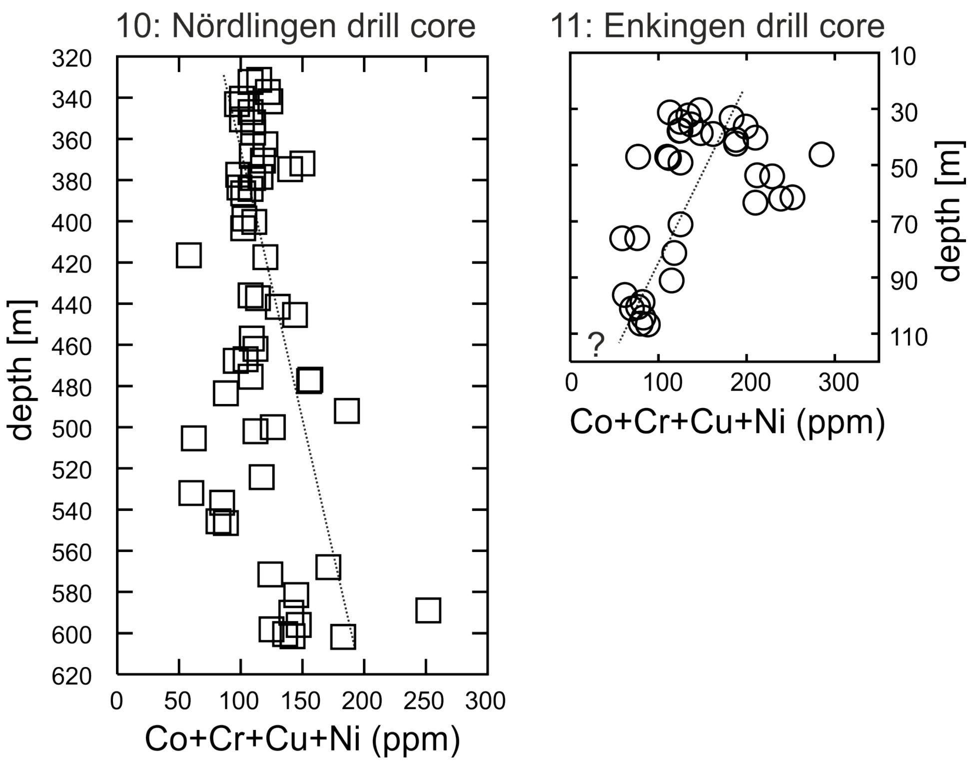
Th-Nb diagram



Th-Nb diagram of Ries target rock (gray field, top right shortened), suevite whole-rock (solid line), and impact melt (dashed lines). Blue dots show average outer suevite whole-rock of each locality in the western area; red dots are average outer suevite whole-rock of locality in the eastern area; red triangle shows average impact melt rock at Polsingen with numbering from Figure 1. Open squares and circles represent the chemical trend from bottom (average) to top (average) of suevite whole-rock of both drill cores, with subdivision as shown in Figure 2 and numbering of localities as shown in Figure 1A. B: Detail of A; sample localities as in Figure 1A. Th and Nb contents localites 1-4 below detection limit (b.d.l.; Th <15 ppm, Nb <10 ppm, XRF).

DR4

Crater suevite Co+Cr+Cu+Ni vs. depth diagram



It is known from drill core FBN 73, that the footwall lithologies in the West get more mafic with increasing depth (Bayerisches Geologisches Landesamt 1974); so, with progressive ejection more mafic rocks get incorporated into the currents, the Co+Cr+Cu+Ni values increase. The crater suevite of the drill core Nördlingen (location 10 in Figure 1a) gets more mafic with increasing depth.

In addition the data of the drill core Enkingen (Reimold et al., 2013) are shown.

The suevite of the drill core Enkingen (location 11 in Figure 1a) gets less mafic with increasing depth. Question mark at Enkingen location: Drilling ends before contact to crystalline basement is reached.

DR4

Chemical data of drill core Nördlingen FBN 73

Preparation of suevite samples for whole-rock geochemical data set:

Suevite samples from which only lithic and mineral clasts larger than approx. 1 cm have been removed.

Analytical methods:

Drill core Nördlingen FBN 73 crater suevite whole-rock analyses were carried out by XRF with a BRUKER AXS S8 TIGER instrument at Museum für Naturkunde Berlin (for more informations see Raschke et al., 2013).

The data listed in table DR3 1-3 are averages of two consecutive FBN 73 samples, because they are more representative. The sample numbers consist of the drill hole name (FBN 73) and the depth (in m) in the drill core profile (e.g., FBN 73 331,40). Thus the average value represents the average composition of two samples in a specific section of the drill core.

All drill core FBN 73 data are available online (Siegert et al., 2017).

Geochemical data of drill core Nördlingen FBN 73 crater suevite

Sample FBN 73 [m]	FBN73 331.40 332.40	FBN73 337.30 340.55	FBN73 341.85 343.20	FBN73 347.00 350.58	FBN73 352.00 357.00	
	melt-rich suevite	melt-rich suevite	melt-rich suevite	melt-rich suevite	melt-rich suevite	
average	**331.90** 1σ	**338.93** 1σ	**342.53** 1σ	**348.79** 1σ	**354.50** 1σ	**d.l.**
SiO2 (wt.%)	62 ± 1	59 ± 1	62 ± 2	61 ± 1	61 ± 1	1
TiO2	0.75 ± 0.04	0.76 ± 0.03	0.68 ± 0.08	0.69 ± 0.01	0.72 ± 0.04	0.01
Al2O3	14.6 ± 0.1	14.0 ± 0.1	13.9 ± 0.3	13.9 ± 0.1	14.2 ± 0.1	0.5
Fe2O3	5.57 ± 0.02	5.37 ± 0.12	5.21 ± 0.49	4.94 ± 0.18	5.06 ± 0.42	0.05
MnO	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.1
MgO	3.1 ± 0.2	3.1 ± 0.2	2.8 ± 0.3	2.7 ± 0.1	2.7 ± 0.3	0.1
CaO	2.3 ± 0.2	3.9 ± 0.2	3.0 ± 0.2	4.3 ± 0.5	3.6 ± 0.2	0.1
Na2O	4.2 ± 0.2	4.0 ± 0.2	4.2 ± 0.2	4.0 ± 0.1	4.3 ± 0.1	0.1
K2O	2.9 ± 0.1	2.8 ± 0.5	3.0 ± 0.2	2.8 ± 0.1	3.1 ± 0.1	0.1
P2O5	0.2 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.1
LOI	3.7 ± 0.3	6.1 ± 1.3	4.5 ± 0.4	5.3 ± 0.4	4.6 ± 0.3	0.1
Total	99.46 ± 0.08	99.48 ± 0.29	99.28 ± 0.07	99.54 ± 0.14	99.42 ± 0.09	
Ba (ppm)	982 ± 214	859 ± 170	634 ± 43	653 ± 27	697 ± 57	10
Ce	76 ± 5	78 ± 5	73 ± 11	68 ± 6	74 ± 4	10
Co	11 ± 1	12 ± 1	11 ± 2	10 ± 3	10 ± 3	5
Cr	46 ± 2	45 ± 8	45 ± 8	43 ± 2	45 ± 1	5
Cu	29 ± 1	30 ± 1	29 ± 2	28 ± 1	31 ± 1	15
Ga	18 ± 1	17 ± 1	17 ± 1	17 ± 1	18 ± 8	15
La	37 ± 5	35 ± 2	32 ± 3	30 ± 1	36 ± 4	10
Mo	<10	<10	<10	<10	<10	10
Nb	10 ± 5	<10	10 ± 5	<10	11 ± 5	10
Ni	26 ± 1	25 ± 1	26 ± 2	24 ± 1	25 ± 1	5
Pb	45 ± 6	48 ± 7	57 ± 2	64 ± 5	62 ± 5	15
Rb	96 ± 1	100 ± 9	102 ± 1	99 ± 3	105 ± 3	5
Sc	17 ± 1	15 ± 3	19 ± 2	15 ± 1	16 ± 1	5
Sr	444 ± 121	369 ± 9	294 ± 7	302 ± 16	296 ± 14	5
Th	<15	<15	<15	<15	<15	15
U	<10	<10	<10	<10	<10	10
V	106 ± 2	106 ± 6	101 ± 8	101 ± 2	102 ± 2	5
Y	21 ± 1	20 ± 3	23 ± 2	20 ± 1	22 ± 5	10
Zn	70 ± 2	72 ± 2	74 ± 8	72 ± 2	73 ± 2	15
Zr	185 ± 3	182 ± 12	177 ± 4	175 ± 9	183 ± 12	10

Sample FBN 73 [m]	FBN73 362.67 368.30	FBN73 370.63 372.00	FBN73 374.70 377.50	FBN73 378.50 379.00	FBN73 383.64 384.35	
	melt-rich suevite	melt-rich suevite	melt-rich suevite	melt-rich suevite	melt-rich suevite	
average	**365.49** 1σ	**371.32** 1σ	**376.10** 1σ	**378.75** 1σ	**384.00** 1σ	**d.l.**
SiO2 (wt.%)	61 ± 1	59 ± 1	61 ± 1	60 ± 1	60 ± 1	1
TiO2	0.74 ± 0.02	0.79 ± 0.06	0.69 ± 0.02	0.69 ± 0.03	0.72 ± 0.02	0.01
Al2O3	14.5 ± 0.3	14.4 ± 0.2	14.6 ± 0.1	14.6 ± 0.3	14.5 ± 0.4	0.5
Fe2O3	5.32 ± 0.01	5.84 ± 0.38	4.93 ± 0.01	5.23 ± 0.07	5.18 ± 0.30	0.05
MnO	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.1
MgO	2.9 ± 0.1	3.3 ± 0.2	2.7 ± 0.1	2.8 ± 0.1	2.6 ± 0.1	0.1
CaO	3.4 ± 0.1	3.4 ± 0.1	3.6 ± 0.2	3.4 ± 0.1	4.0 ± 0.3	0.1
Na2O	4.5 ± 0.1	4.6 ± 0.1	4.8 ± 0.3	4.3 ± 0.3	4.2 ± 0.1	0.1
K2O	2.9 ± 0.1	2.6 ± 0.2	2.8 ± 0.1	2.6 ± 0.1	3.0 ± 0.1	0.1
P2O5	0.2 ± 0.1	0.3 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.3 ± 0.1	0.1
LOI	4.2 ± 0.1	5.1 ± 0.5	4.3 ± 0.1	5.7 ± 1.5	4.5 ± 0.9	0.1
Total	99.66 ± 0.12	99.28 ± 0.15	99.74 ± 0.18	99.40 ± 0.06	99.23 ± 0.09	
Ba (ppm)	622 ± 1	829 ± 170	604 ± 7	1140 ± 478	992 ± 416	10
Ce	77 ± 5	80 ± 12	79 ± 4	77 ± 5	82 ± 2	10
Co	12 ± 2	12 ± 3	11 ± 1	11 ± 1	11 ± 1	5
Cr	46 ± 3	62 ± 14	55 ± 15	47 ± 2	37 ± 4	5
Cu	32 ± 3	32 ± 1	27 ± 2	31 ± 1	30 ± 1	15
Ga	19 ± 1	19 ± 8	17 ± 1	19 ± 1	18 ± 1	15
La	42 ± 4	40 ± 5	35 ± 6	35 ± 2	36 ± 2	10
Mo	<10	<10	<10	<10	<10	10
Nb	<10	11 ± 1	<10	10 ± 5	<10	10
Ni	26 ± 2	29 ± 2	27 ± 7	26 ± 2	27 ± 1	5
Pb	45 ± 1	29 ± 2	36 ± 10	35 ± 8	37 ± 14	15
Rb	102 ± 1	103 ± 4	101 ± 4	93 ± 8	96 ± 5	5
Sc	19 ± 1	20 ± 3	17 ± 1	17 ± 2	16 ± 2	5
Sr	283 ± 3	311 ± 13	283 ± 4	618 ± 338	552 ± 272	5
Th	<15	<15	<15	<15	<15	15
U	<10	<10	<10	<10	<10	10
V	109 ± 4	115 ± 8	97 ± 1	102 ± 2	99 ± 7	5
Y	23 ± 1	24 ± 1	22 ± 1	20 ± 5	22 ± 1	10
Zn	71 ± 1	72 ± 4	68 ± 2	70 ± 5	70 ± 2	15
Zr	178 ± 2	186 ± 11	171 ± 13	171 ± 11	187 ± 7	10

Geochemical data of drill core Nördlingen FBN 73 crater suevite

	FBN73	FBN73	FBN73	FBN73	FBN73	
Sample	386.50	400.33	416.55	436.00	441.60	
FBN 73 [m]	398.75	403.47	417.50	437.40	445.50	
	melt-rich suevite	melt-rich suevite	melt-rich suevite	melt-rich suevite	melt-rich suevite	
average	**392.63** 1σ	**401.90** 1σ	**417.03** 1σ	**436.70** 1σ	**443.55** 1σ	**d.l.**
SiO2 (wt.%)	58 ± 2	62 ± 1	63 ± 3	60 ± 1	59 ± 1	1
TiO2	0.77 ± 0.08	0.74 ± 0.02	0.59 ± 0.20	0.75 ± 0.01	0.80 ± 0.06	0.01
Al2O3	14.7 ± 0.3	15.0 ± 0.3	13.8 ± 2.2	15.5 ± 0.3	14.9 ± 0.1	0.5
Fe2O3	6.07 ± 1.31	5.39 ± 0.08	4.91 ± 0.24	5.51 ± 0.23	6.45 ± 0.27	0.05
MnO	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.1
MgO	3.2 ± 0.8	2.8 ± 0.1	2.3 ± 0.5	3.1 ± 0.1	4.0 ± 0.2	0.1
CaO	4.1 ± 0.1	4.3 ± 0.2	4.3 ± 1.3	2.7 ± 0.1	3.0 ± 0.1	0.1
Na2O	4.8 ± 0.4	3.8 ± 0.3	4.4 ± 0.9	5.5 ± 0.2	4.9 ± 0.2	0.1
K2O	3.2 ± 0.2	2.7 ± 0.1	2.2 ± 0.3	2.6 ± 0.1	2.3 ± 0.2	0.1
P2O5	0.2 ± 0.1	0.3 ± 0.1	0.1 ± 0.1	0.3 ± 0.1	0.3 ± 0.1	0.1
LOI	4.1 ± 0.1	3.0 ± 0.1	3.9 ± 0.2	4.0 ± 0.2	3.8 ± 0.3	0.1
Total	99.24 ± 0.02	99.74 ± 0.39	100.08 ± 0.25	99.41 ± 0.12	99.91 ± 0.02	
Ba (ppm)	752 ± 171	861 ± 7	713 ± 86	708 ± 3	773 ± 142	10
Ce	78 ± 7	73 ± 5	78 ± 11	93 ± 2	72 ± 14	10
Co	10 ± 3	12 ± 1	9 ± 4	12 ± 1	14 ± 3	5
Cr	40 ± 4	40 ± 4	28 ± 25	45 ± 2	60 ± 8	5
Cu	30 ± 3	33 ± 8	35 ± 5	31 ± 2	32 ± 1	15
Ga	18 ± 2	18 ± 8	18 ± 8	19 ± 1	19 ± 8	15
La	37 ± 5	33 ± 1	36 ± 7	48 ± 2	39 ± 8	10
Mo	<10	<10	<10	<10	<10	10
Nb	10 ± 5	<10	10 ± 5	10 ± 5	11 ± 5	10
Ni	24 ± 2	22 ± 3	18 ± 8	24 ± 1	32 ± 3	5
Pb	47 ± 5	65 ± 5	21 ± 3	22 ± 2	24 ± 3	15
Rb	97 ± 10	99 ± 2	76 ± 16	95 ± 7	105 ± 7	5
Sc	17 ± 1	18 ± 1	13 ± 5	16 ± 2	22 ± 3	5
Sr	281 ± 7	344 ± 7	304 ± 37	330 ± 10	350 ± 80	5
Th	<15	<15	<15	<15	<15	15
U	<10	<10	<10	<10	<10	10
V	105 ± 11	112 ± 3	87 ± 28	104 ± 5	131 ± 7	5
Y	21 ± 1	22 ± 5	21 ± 5	22 ± 1	24 ± 1	10
Zn	70 ± 1	69 ± 2	60 ± 17	67 ± 1	76 ± 4	15
Zr	191 ± 1	181 ± 4	208 ± 11	206 ± 12	179 ± 19	10

	FBN73	FBN73	FBN73	FBN73	FBN73	
Sample	457.00	467.00	475.54	477.70	492.15	
FBN 73 [m]	462.00	467.80	477.00	483.58	500.00	
	melt-rich suevite	melt-rich suevite	melt-rich suevite	melt-rich suevite	melt-rich suevite	
average	**459.50** 1σ	**467.40** 1σ	**476.27** 1σ	**480.64** 1σ	**496.08** 1σ	**d.l.**
SiO2 (wt.%)	61 ± 1	61 ± 1	60 ± 1	60 ± 1	60 ± 1	1
TiO2	0.69 ± 0.02	0.72 ± 0.02	0.73 ± 0.03	0.70 ± 0.05	0.82 ± 0.03	0.01
Al2O3	14.8 ± 0.5	14.8 ± 0.2	14.9 ± 0.1	15.1 ± 0.3	15.1 ± 0.1	0.5
Fe2O3	5.33 ± 0.22	5.41 ± 0.10	6.07 ± 0.56	5.49 ± 0.86	6.08 ± 0.03	0.05
MnO	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.1
MgO	3.1 ± 0.1	3.1 ± 0.1	3.6 ± 0.6	3.3 ± 0.8	3.4 ± 0.1	0.1
CaO	2.9 ± 0.1	3.2 ± 0.1	3.7 ± 0.3	3.9 ± 0.1	3.6 ± 0.2	0.1
Na2O	4.9 ± 0.1	4.9 ± 0.1	4.9 ± 0.1	5.0 ± 0.2	5.1 ± 0.3	0.1
K2O	2.7 ± 0.1	2.7 ± 0.1	2.6 ± 0.1	2.4 ± 0.1	2.3 ± 0.1	0.1
P2O5	0.2 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.1
LOI	3.8 ± 0.9	3.1 ± 0.4	2.3 ± 0.4	3.5 ± 1.0	3.4 ± 0.5	0.1
Total	99.56 ± 0.28	99.51 ± 0.13	99.38 ± 0.07	100.00 ± 0.13	99.71 ± 0.01	
Ba (ppm)	684 ± 70	725 ± 5	626 ± 40	768 ± 171	845 ± 74	10
Ce	69 ± 2	76 ± 3	71 ± 11	64 ± 4	76 ± 14	10
Co	11 ± 3	11 ± 1	13 ± 2	12 ± 3	14 ± 3	5
Cr	45 ± 1	39 ± 2	56 ± 14	50 ± 18	51 ± 2	5
Cu	31 ± 2	28 ± 2	34 ± 3	32 ± 5	63 ± 27	15
Ga	18 ± 8	18 ± 8	18 ± 1	18 ± 8	19 ± 1	15
La	30 ± 4	42 ± 5	28 ± 3	27 ± 5	33 ± 5	10
Mo	<10	<10	<10	<10	<10	10
Nb	<10	<10	10 ± 5	<10	10 ± 5	10
Ni	25 ± 1	23 ± 3	30 ± 6	27 ± 7	29 ± 2	5
Pb	20 ± 1	21 ± 1	18 ± 2	22 ± 7	19 ± 8	15
Rb	98 ± 5	95 ± 2	91 ± 5	85 ± 2	82 ± 1	5
Sc	18 ± 3	20 ± 2	19 ± 2	20 ± 3	21 ± 1	5
Sr	276 ± 1	276 ± 1	269 ± 9	274 ± 14	284 ± 19	5
Th	<15	<15	<15	<15	<15	15
U	<10	<10	<10	<10	<10	10
V	106 ± 3	102 ± 1	126 ± 11	116 ± 22	124 ± 2	5
Y	21 ± 5	21 ± 5	22 ± 1	19 ± 1	23 ± 2	10
Zn	65 ± 2	67 ± 1	66 ± 8	63 ± 1	73 ± 1	15
Zr	162 ± 2	176 ± 2	159 ± 18	157 ± 16	180 ± 14	10

Geochemical data of drill core Nördlingen FBN 73 crater suevite

Sample FBN 73 [m]	FBN73 502.00 505.40	FBN73 524.30	FBN73 532.05 536.75	FBN73 545.70 546.56	FBN73 568.00 571.50	
	melt-rich suevite	melt-rich suevite	melt-poor suevite	melt-poor suevite	melt-poor suevite	
average	**503.70** 1σ	**524,30**	**534.40** 1σ	**546.13** 1σ	**569.75** 1σ	**d.l.**
SiO2 (wt.%)	62 ± 2	59	63 ± 2	61 ± 1	59 ± 1	1
TiO2	0.66 ± 0.08	0.72	0.64 ± 0.05	0.76 ± 0.01	0.68 ± 0.04	0.01
Al2O3	14.4 ± 0.4	14.9	15.0 ± 0.1	14.9 ± 0.2	14.8 ± 0.4	0.5
Fe2O3	5.50 ± 1.15	5.62	5.21 ± 0.52	5.57 ± 0.08	6.68 ± 0.20	0.05
MnO	0.1 ± 0.1	0.1	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.1
MgO	2.7 ± 0.7	3.0	2.5 ± 0.4	2.6 ± 0.1	4.1 ± 0.4	0.1
CaO	3.4 ± 0.1	3.4	3.3 ± 0.4	3.9 ± 0.1	5.0 ± 0.1	0.1
Na2O	4.6 ± 0.7	5.9	3.9 ± 0.3	3.6 ± 0.2	3.8 ± 0.2	0.1
K2O	3.0 ± 0.9	2.0	3.1 ± 0.3	3.4 ± 0.1	2.0 ± 0.1	0.1
P2O5	0.2 ± 0.1	0.2	0.2 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.1
LOI	2.5 ± 0.3	4.1	2.6 ± 0.5	3.4 ± 0.5	3.2 ± 0.1	0.1
Total	99.34 ± 0.24	99.03	99.58 ± 0.05	99.36 ± 0.24	99.54 ± 0.01	
Ba (ppm)	782 ± 161	738	1065 ± 305	1384 ± 120	483 ± 10	10
Ce	62 ± 4	76	66 ± 9	72 ± 2	48 ± 4	10
Co	10 ± 2	11	10 ± 2	9 ± 2	16 ± 1	5
Cr	29 ± 12	48	21 ± 10	26 ± 2	69 ± 18	5
Cu	30 ± 7	31	27 ± 1	30 ± 4	35 ± 2	15
Ga	18 ± 8	18	20 ± 1	20 ± 1	17 ± 1	15
La	31 ± 12	36	27 ± 13	31 ± 2	23 ± 6	10
Mo	<10	<10	<10	<10	<10	10
Nb	<10	<10	<10	<10	<10	10
Ni	19 ± 5	27	16 ± 2	21 ± 1	28 ± 3	5
Pb	21 ± 4	21	21 ± 4	20 ± 2	25 ± 8	15
Rb	105 ± 34	73	147 ± 15	195 ± 8	82 ± 1	5
Sc	20 ± 3	21	22 ± 1	19 ± 1	25 ± 3	5
Sr	282 ± 17	258	301 ± 2	301 ± 2	297 ± 14	5
Th	15 ± 8	<15	<15	<15	<15	15
U	<10	<10	<10	<10	<10	10
V	99 ± 29	108	103 ± 15	109 ± 12	156 ± 4	5
Y	20 ± 4	21	24 ± 3	22 ± 1	21 ± 3	10
Zn	62 ± 8	71	73 ± 5	80 ± 10	73 ± 7	15
Zr	170 ± 17	181	162 ± 14	152 ± 6	149 ± 19	10

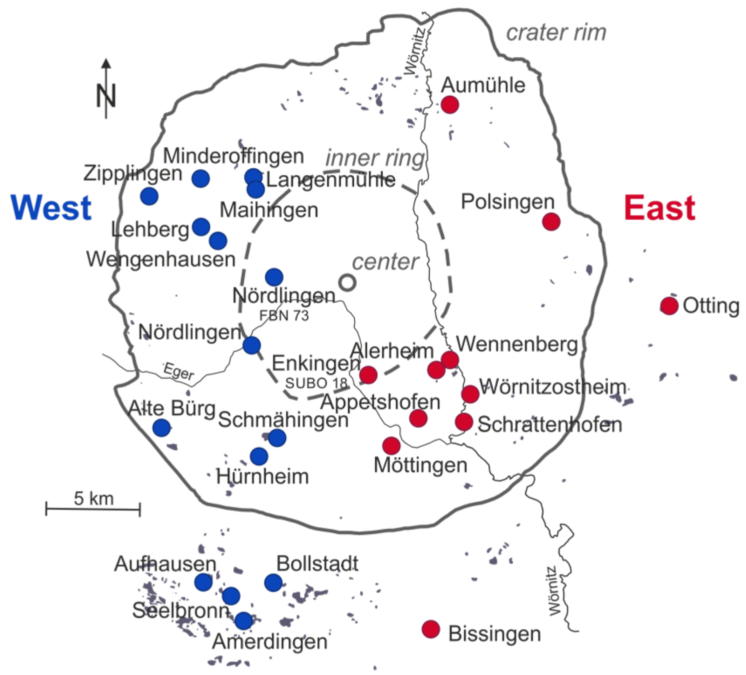
Sample FBN 73 [m]	FBN73 581.60 586.50	FBN73 589.00 590.10	FBN73 596.00 598.20	600.50 601.50 601.90	
	melt-poor suevite	melt-poor suevite	melt-poor suevite	melt-poor suevite	
average	**584.05** 1σ	**589.55** 1σ	**597.10** 1σ	**601.30** 1σ	**d.l.**
SiO2 (wt.%)	57 ± 2	57 ± 2	58 ± 1	58 ± 2	1
TiO2	0.68 ± 0.01	0.67 ± 0.01	0.67 ± 0.01	0.74 ± 0.07	0.01
Al2O3	14.8 ± 0.2	14.8 ± 0.1	15.0 ± 0.1	14.6 ± 0.3	0.5
Fe2O3	7.53 ± 0.79	7.57 ± 0.96	6.57 ± 0.15	6.26 ± 0.08	0.05
MnO	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.1
MgO	4.8 ± 0.7	4.9 ± 1.0	3.6 ± 0.1	3.7 ± 0.2	0.1
CaO	5.8 ± 0.2	6.1 ± 0.8	5.0 ± 0.1	5.6 ± 0.7	0.1
Na2O	3.8 ± 0.2	4.0 ± 0.2	4.2 ± 0.1	3.0 ± 0.6	0.1
K2O	1.6 ± 0.1	1.3 ± 0.4	2.1 ± 0.1	3.3 ± 0.9	0.1
P2O5	0.1 ± 0.1	0.1 ± 0.1	0.2 ± 0.1	0.3 ± 0.1	0.1
LOI	3.9 ± 0.6	2.4 ± 0.3	3.8 ± 0.4	4.2 ± 1.0	0.1
Total	99.65 ± 0.16	99.31 ± 0.02	99.39 ± 0.08	99.77 ± 0.32	
Ba (ppm)	450 ± 46	415 ± 167	1073 ± 491	2149 ± 308	10
Ce	40 ± 6	33 ± 7	50 ± 4	62 ± 11	10
Co	18 ± 2	20 ± 4	14 ± 1	15 ± 1	5
Cr	176 ± 113	100 ± 47	52 ± 3	62 ± 20	5
Cu	37 ± 1	40 ± 4	42 ± 6	46 ± 5	15
Ga	16 ± 1	16 ± 8	18 ± 1	17 ± 1	15
La	15 ± 5	16 ± 5	15 ± 4	17 ± 4	10
Mo	<10	<10	<10	<10	10
Nb	<10	<10	<10	<10	10
Ni	49 ± 19	37 ± 9	28 ± 1	31 ± 5	5
Pb			17 ± 8	44 ± 8	15
Rb	71 ± 1	61 ± 25	110 ± 24	154 ± 53	5
Sc	29 ± 4	31 ± 7	23 ± 1	20 ± 2	5
Sr	276 ± 24	277 ± 12	290 ± 3	296 ± 6	5
Th	<15	<15	<15	<15	15
U	<10	<10	<10	<10	10
V	179 ± 14	173 ± 28	141 ± 2	138 ± 9	5
Y	22 ± 2	21 ± 1	20 ± 1	19 ± 1	10
Zn	70 ± 8	66 ± 2	74 ± 5	130 ± 84	15
Zr	113 ± 27	115 ± 26	145 ± 5	149 ± 27	10

DR5

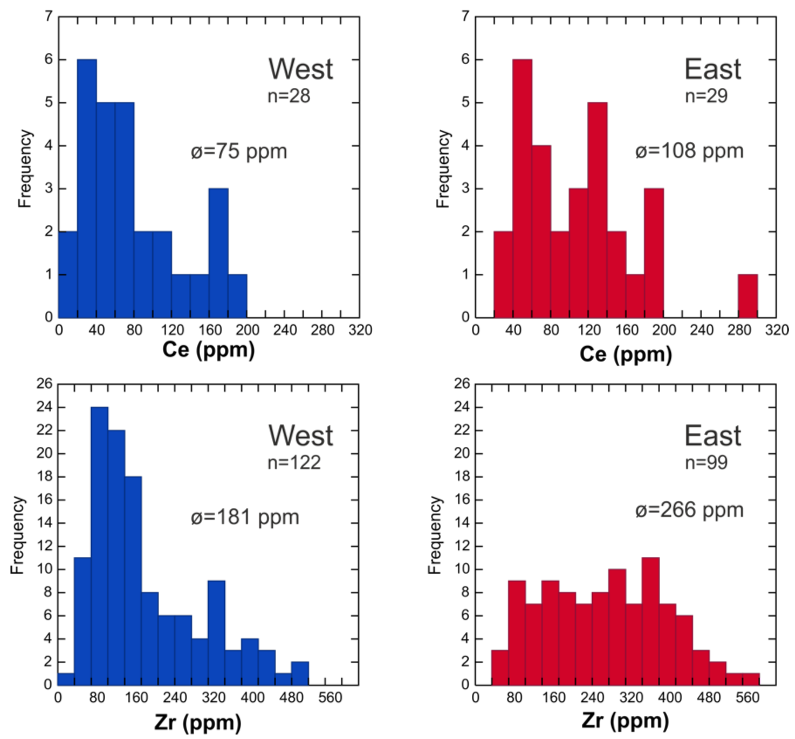
Ries impact target lithologies

a) sample locations of target lithologies grouped in western (blue) and eastern (red) area of the Ries structure, b) Ce and Zr histograms of Ries impact target lithologies divided in western and eastern area. Target rock fragments show in average lower Ce and Zr values at western suevite locations than at eastern sites. Data from Matthes et al. (1977), Siebenschock et al. (1998), Reimold et al. (2013), and this study (Schmitt et al., 2017).

a



b



DR6

Photo locations figure 1

b: very poorly sorted outer suevite, quarry Otting
c: very poorly sorted, massive lapilli-tuff from Adeje ignimbrite of Cañadas volcano, Tenerife
d: elutriation pipe in outer suevite, quarry Aumühle
e: elutriation pipe in the Zaragoza ignimbrite, central Mexico (Carrasco-Nuñez and Branney, 2005)
f: fine-grained basal layer of outer suevite with low-angle cross-lamination and a sharp basal contact, quarry Otting
g: cross-laminated base in the Campanian ignimbrite, Italy (see fig. 6.14 of Branney and Kokelaar, 2002)

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