

**Comparison of reference values (RV) and measurement uncertainties (U)
for Six Certified Reference Materials with HAL XRF determinations**

RM	AGV-1 ¹				BHVO-1 ¹			
	RV	U	<i>n</i> = 7		RV	U	<i>n</i> = 33	
			end Oct 2016 to end Jun 2017				mid Oct 2016 to end Jun 2017	
# HAL analyses Time frame			HAL ave.	2*SD			HAL ave.	2*SD
SiO₂	59.38	0.41	59.13	0.36	49.79	0.12	49.86	0.43
TiO₂	1.050	0.014	1.049	0.010	2.742	0.012	2.755	0.025
Al₂O₃	17.11	0.13	17.09	0.14	13.69	0.05	13.66	0.12
FeO*	6.08	0.07	6.25	0.07	11.09	0.04	11.13	0.11
MnO	0.097	0.002	0.098	0.001	0.169	0.001	0.171	0.002
MgO	1.51	0.021	1.54	0.022	7.21	0.032	7.12	0.061
CaO	4.89	0.05	4.92	0.06	11.43	0.04	11.43	0.11
Na₂O	4.25	0.050	4.33	0.080	2.31	0.022	2.33	0.075
K₂O	2.935	0.037	2.948	0.022	0.526	0.005	0.529	0.006
P₂O₅	0.493	0.0085	0.491	0.0064	0.277	0.0024	0.270	0.0033
sumMaj	97.79		97.84	0.49	99.24		99.26	0.72
Ni	15	0.3	16	1.0	120	1.5	120	2.2
Cr	9	0.3	11	2.1	288	3.9	287	4.5
V	119	1.6	122	4.0	314	3.2	317	5.7
Sc	12.4	0.2	12.9	0.8	31.4	0.4	31.4	1.6
Cu	58	0.6	60	2.7	137	1.6	139	3.8
Zn	87	1.2	89	2.6	105	1.5	104	3.8
Ga	20.4	0.27	20.8	1.22	21.3	0.42	21.3	1.66
Ba	1218	7.2	1208	15.6	134	2.5	128	6.8
Rb	67.8	0.64	67.5	1.54	9.5	0.10	8.9	1.12
Cs	1.3	0.022	2.1	3.0	0.1	0.003	1.0	2.6
Sr	661	3.7	669	10.1	399	5.0	401	5.1
Y	19.7	0.31	19.4	1.05	26.2	0.31	27.4	1.50
Zr	232	2.4	228	5.4	175	1.3	172	2.6
Hf	5.1	0.04	4.8	0.27	4.4	0.11	4.1	0.76
Nb	14.5	0.23	14.5	0.87	18.5	0.23	19.1	1.30
Ta	0.87	0.02	0.30	2.38	1.17	0.02	0.90	1.79
Mo	2.1	0.08	2.7	1.00	1.1	0.06	2.1	1.17
La	38.2	0.27	36.9	4.55	15.4	0.10	15.8	3.76
Ce	68.6	0.54	67.9	3.31	38.1	0.22	37.5	6.28
Nd	32.1	0.31	30.1	1.88	24.8	0.26	23.5	2.85
Sm	5.8	0.06	5.3	0.29	6.2	0.08	5.3	0.58
Dy	3.6	0.04	4.1	0.24	5.3	0.03	4.7	0.33
Yb	1.7	0.02	2.6	2.80	2.0	0.02	3.3	2.95
Th	6.35	0.06	5.46	1.67	1.23	0.02	1.21	1.53
U	1.90	0.02	2.83	2.12	0.42	0.005	0.70	1.31
Tl	0.34	0.031	1.32	3.48	0.05	0.004	0.70	2.27
Pb	36.4	0.44	37.1	1.56	2.0	0.07	2.0	2.38
Bi	0.045	0.012	0.64	1.57	0.012	0.002	0.51	1.44

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RM	G-1 ²				GSP-1 ³			
	# HAL analyses	<i>n</i> = 23			<i>n</i> = 4			
		Time frame	mid Feb 2017 to end Jun 2017			end Nov 2016 to end Jun 2017		
	RV	U	HAL ave.	2*SD	RV	U	HAL ave.	2*SD
SiO₂	72.51	0.19	72.27	0.33	67.22	0.24	67.06	0.28
TiO₂	0.270	0.010	0.264	0.003	0.65	0.03	0.666	0.007
Al₂O₃	14.23	0.21	14.29	0.05	15.10	0.26	15.05	0.06
FeO*	1.76	0.13	1.78	0.01	3.86	0.13	3.95	0.05
MnO	0.0276	0.006	0.0274	0.0004	0.04	0.0036	0.0409	0.0003
MgO	0.36	0.07	0.45	0.008	0.96	0.07	1.00	0.017
CaO	1.37	0.06	1.31	0.01	2.07	0.04	2.00	0.02
Na₂O	3.33	0.05	3.53	0.048	2.80	0.09	2.86	0.084
K₂O	5.51	0.06	5.50	0.03	5.51	0.08	5.56	0.03
P₂O₅	0.08	0.005	0.083	0.0012	0.28	0.02	0.279	0.0032
sumMaj	99.44		99.50	0.43	98.49		98.48	0.35
Ni	3.4	1.8	8.6	1.7	8.8	1.9	9.7	1.6
Cr	20	6	25	2.4	13	3	15	2.2
V	18	4	17	1.4	53	7	55	2.0
Sc	2.8	0.3	2.5	0.7	5.9	0.6	5.8	0.8
Cu	12	2	25	2	33	5	32	2
Zn	45	8	48	1.2	104	10	104	2.3
Ga	19.5	1.5	20.2	1.4	23	3	22.3	1.0
Ba	1080	60	1036	9.5	1290	10	1301	16.1
Rb	214	1	212	2	254	2	258	4
Cs	1.6	0.3	1.5	2.5	1.02	0.19	0.7	2.2
Sr	248	11	251	2.8	234	3	232	3.6
Y	13	0.3	11.8	1.49	26	1.7	26.5	2.05
Zr	201	23	213	1.5	571	35	600	10.3
Hf	5.4	0.6	5.8	0.74	16.1	1.4	16.8	0.87
Nb	22.6	1.0	21.8	0.76	27.9	1.2	27.7	1.06
Ta	1.5	0.4	2.4	2.0	0.85	0.19	1.2	2.3
Mo	6.8	1.7	7.2	0.63	0.8	0.6	1.3	1.3
La	105	16	98	2.4	184	18	186	2.7
Ce	173	24	180	6.9	437	26	428	4.5
Nd	57	11	57	3.3	200	17	203	0.7
Sm	8.3	1.6	8.5	0.66	26.3	2.4	28.2	1.02
Dy	2.4	0.3	1.9	0.29	5.5	0.7	4.7	0.28
Yb	1.0	0.3	2.2	2.14	1.7	0.3	1.2	1.86
Th	51	7	50.2	1.9	106	6	106	3
U	3.4	0.5	4.4	2.4	2.54	0.12	3.2	1.3
Tl	1.23	0.13	0.32	1.33	1.43	0.15	1.31	4.58
Pb	46	2	46	2	55	2	56	1.3
Bi	0.05	0.01	0.00	0.82	0.039	0.006	0.0	2.3

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RM	JR-2 ⁴				SCo-1 ⁵			
	RV	U	<i>n</i> = 3		RV	U	<i>n</i> = 3	
			end Nov 2016 to end Jun 2017				mid Nov 2016 to mid Jan 2017	
# HAL analyses			HAL ave.	2*SD			HAL ave.	2*SD
Time frame								
SiO₂	75.69	0.30	75.54	0.12	62.8	0.66	62.55	0.25
TiO₂	0.07	0.004	0.065	0.001	0.63	0.06	0.588	0.004
Al₂O₃	12.72	0.20	12.69	0.04	13.7	0.21	13.64	0.04
FeO*	0.69	0.09	0.66	0.01	4.62	0.16	4.70	0.06
MnO	0.112	0.001	0.1136	0.0008	0.053	0.004	0.0524	0.0003
MgO	0.04	0.05	0.11	0.018	2.72	0.18	2.69	0.019
CaO	0.50	0.03	0.51	0.01	2.62	0.20	2.57	0.04
Na₂O	3.99	0.07	4.01	0.062	0.90	0.06	0.92	0.003
K₂O	4.45	0.04	4.52	0.04	2.77	0.08	2.76	0.03
P₂O₅	0.012	0.002	0.010	0.0005	0.21	0.02	0.204	0.0014
sumMaj	98.28		98.23	0.16	90.96		90.67	0.38
Ni	2.0	1.6	1.5	1.9	27	4	26	1.4
Cr	2.0	1.2	5.8	2.7	68	5	71	1.7
V	3.0	1.8	2.1	1.5	131	13	136	1.5
Sc	5.6	1.2	4.9	1.0	11.6	1.0	11.5	0.2
Cu	1.4	0.5	3.0	3.6	29	2	30.4	0.2
Zn	27.8	2.7	25.9	0.8	100	8	103	1
Ga	17.9	2.5	18.0	0.3	15	nd	17.2	1.4
Ba	40	17	30	0.8	570	30	575	1.7
Rb	303	24	307	4	110	4	115	2
Cs	25.0	5.5	27.5	1.5	7.8	0.7	7.6	4.0
Sr	8.1	2.3	7.2	1.5	170	16	172	1.5
Y	51.1	6.1	48.4	1.3	26	4	24.9	1.1
Zr	90.3	6.4	90.9	1.8	169	30	174	1.1
Hf	5.14	0.49	3.9	0.9	4.75	0.14	4.5	0.5
Nb	18.7	2.8	15.0	1.1	11	nd	11.3	0.4
Ta	2.06	0.52	0.8	2.4	0.804	0.024	0.0	0.9
Mo	3.4	0.7	2.4	1.5	1.4	0.2	0.8	0.5
La	14.9	2.3	14.6	1.2	29.3	1.0	29.6	0.1
Ce	37.8	5.1	37.4	6.5	56.7	6.0	56.4	5.5
Nd	20.4	3.4	18.5	1.2	26.0	2.0	24.2	2.4
Sm	5.63	0.62	5.44	0.38	5.14	0.15	4.73	0.46
Dy	6.63	1.05	7.5	0.21	4.2	0.2	4.3	0.13
Yb	5.33	0.65	6.2	3.2	2.27	0.07	2.0	3.2
Th	31.4	5.6	31.7	3.0	9.0	0.5	10.0	3.4
U	10.9	1.4	10.1	0.8	3.00	0.09	3.6	1.5
Tl	1.85	0.07	0.17	4.39			0.0	2.5
Pb	21.5	3.4	21.8	1.4	31	3	30.1	0.3
Bi	0.62	0.12	0.1	1.9	0.37	nd	0.1	0.8

Major elements in wt% oxide, trace elements in ppm. For AGV-1 and BHVO-1 U = 2 sigma uncertainty using robust statistics; for other RMs U = 1 sigma standard deviations. All HAL uncertainties are 2 sigma standard deviations. Some data are from literature compilation by the HAL, R. L. Korotev (1996): A Self-consistent compilation of elemental concentration data for 93 Geochemical Reference Samples, *Geostandards Newsletter*, 20: 217-245, or from the GeoREM website (<http://georem.mpch-mainz.gwdg.de/>).

¹ Data from Jochum et. al. (2015): Reference values following ISO guidelines for frequently requested Rock Reference Materials, *Geostandards and Geoanalytical Research*, 40: 333-350.

² Data chiefly from E.S. Gladney, E.A. Jones, E.J. Nickell and I. Roelandts (1991): 1988 compilation of elemental concentration data for USGS DTS-1, G-1, PCC-1 and W-1, *Geostandards Newsletter*, 15: 199-396.

³ Data chiefly from E.S. Gladney, E.A. Jones, E.J. Nickell and I. Roelandts (1992): 1988 compilation of elemental concentration data for USGS AGV-1, GSP-1, and G-2, *Geostandards Newsletter*, 16: 111-300.

⁴ Data chiefly from N. Imai, S. Terashima, S. Itoh and A. Ando (1995): 1994 Compilation of analytical data for minor and trace elements in 17 GSJ Geochemical Reference Samples, "Igneous Rock Series", *Geostandards Newsletter*, 19: 135-213, and K. W. Sims, E.S. Gladney, C. Lundstrom, and N.W. Bower (1988): Elemental concentrations in Japanese Silicate Rock Standards, a comparison with the literature, *Geostandards Newsletter*, 12: 379-389.

⁵ Data chiefly from USGS certificate.