

Reference Material Certificate

Certified Reference Material

IAG BNA-1

Iceland Tholeiitic Basalt

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Geological origin

The Iceland Tholeiitic Basalt reference material, BNA-1, was collected by Dr Michael Wiedenbeck of Helmholtz Zentrum für Geoforschung, GFZ, Potsdam, Germany and Prof. Olgeir Sigmarsson (CNRS-Université Clermont Auvergne, Aubière, France and Institute of Earth Sciences, University of Iceland, Reykjavík, Iceland) from the same quarry believed to be the source of the reference material USGS BIR-1 (Reykjavik Iceland Basalt). This now abandoned quarry is at the top of a hill that is located at 64°05′15″N 21°38′57″W at an elevation of 177 meters above sea level, some 1.1 km NNE of the N1 highway and 15.0 km ESE from the terminal at the Reykjavik City airport. The collected material was processed at the British Geological Survey (BGS), Keyworth, where it was crushed, ground to fine powder, homogenised, divided and packeted under the direction of Dr Charles Gowing.

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Intended use

This certified reference material is designed for use by laboratories undertaking the determination of major and trace element mass fractions in silicate rocks and equivalent matrices for the calibration of a measurement system, the assessment of a measurement procedure, assigning values to other materials, and quality control. Note that the material may be used only for a single purpose in the same measurement process. For example, it must not be used for calibration and method validation at the same time.

Certification programme

- (i) About 200 kg of rock material (Iceland Tholeiitic Basalt) was collected by Dr Michael Wiedenbeck and Prof. Olgeir Sigmarsson in September 2022. Of the collected material, about 80 kg was milled (using hardened chrome steel milling equipment), homogenised, divided and packeted at the British Geological Survey (BGS), Keyworth, UK, under the direction of Dr Charles Gowing.
- (ii) Packets of the material were distributed for analysis to laboratories participating in Round 54 of the IAG GeoPT proficiency testing programme, together with packets of a supplementary test material comprising the established certified reference material BRP-1 (Basalt Ribeirão Preto), provided by the Geological Survey of Brazil. The true identity of the test material provided for co-analysis was concealed from participants. A full analysis of the results of this round is available as reports GeoPT54 (Tholeiitic Basalt, BNA-1) and GeoPT54A (Basalt, CSQ-1, aka BRP-1) (Webb et al. 2024a,b).
- (iii) Certification of IAG BNA-1 was undertaken using the IAG certification protocol (Potts et al. 2019) and is based on the results of the GeoPT54 proficiency testing programme. A full description of the application of this protocol to the certification of IAG BNA-1 is available (Potts et al. 2025), as well as its application to a similar earlier certification of IAG GMN-1 (Meissen Granite) (Potts et al., 2024).

IAG BNA-1 material characteristics

(i) *Particle size distribution*

BNA-1 Particle size distribution				
Sieve size	Particle size retained	Average retained		
(µm)	(µm)	(%)		
106	>106	0.05		
75	<106 - >75	1.43		
63	<75 - >63	3.90		
53	<63 - >53	5.69		
32	<53 - >32	13.65		
	<32	75.28		
	Sum	100.00		

(ii) Mineral composition

Table 2			
Mineral composition of BNA-1			
Mineral	%		
Anorthite	46.0		
Augite	34.1		
Forsterite	19.9		
Magnesite	<0.5		
Cristobalite	<0.5		

XRD data courtesy of the British Geological Survey.

- (iii) Homogeneity testing was undertaken at the British Geological Survey (Keyworth, UK) on nine packets of Iceland Tholeiitic Basalt selected at random from the material prepared for certification. Duplicate test portions of 0.25 g were dissolved by mixed acid digestion (HNO₃, HF, HClO₄) and measured in random order by ICP-MS. A standard F-test was undertaken on the test results which indicated that the material was sufficiently homogeneous for use as a geochemical certified reference material.
- (iv) Stability a formal test for stability was not undertaken but an evaluation of the characteristics of this material provided no indication that reported measurement values would be affected by significant changes in composition over the period of availability of this material.
- (v) Derivation of certified values. Estimates of the composition of this material were provided by assigned and provisional values derived from an analysis of the results submitted to the GeoPT54 proficiency testing programme. Following the requirements of the GeoPT certification protocol (Potts et al. 2019), GeoPT assigned values are reported here as certified values and GeoPT provisional values as indicative values. In both cases, associated uncertainties are derived as standard deviations of the mean following robust statistical analysis of the full GeoPT data set, expanded to give a confidence interval of 95%. Addition confidence in these data was obtained by assessing the results for BRP-1 (Basalt Ribeirão Preto) from round GeoPT54A and undertaking a comparison between the GeoPT assigned values and independently derived certified values (Cotta and Enzweiler 2008). Comparison of these data were satisfactory (Potts et al., 2025).

Certified values

Certified values listed in the Table 3 are based on procedures that are summarised in the International Association of Geoanalysts GeoPT certification protocol and derived from the GeoPT54 proficiency testing round. These values are the best estimates of the true composition of this CRM, together with the 95% confidence limit.

Indicative values

Indicative values in Table 4 are designed to provide guidance on the mass fractions of other selected elements and should be used with caution if validating analytical measurements without additional corroboration.

Table 3 – Part 1					
	Certified Values				
	Iceland Tholeiitic Basalt, BNA-1				
BNA-1	Certified Value X _{pt}	Uncertainty certified value (U)	Number reported results p	Horwitz Target Uncertainty (U)	Quality Factor
	g/100g	g/100g		g/100g	
SiO ₂	47.14	0.15	82	1.06	0.41
TiO ₂	0.899	0.006	86	0.037	0.44
Al₂O ₃	15.35	0.07	84	0.41	0.51
Fe₂O₃T	11.24	0.06	85	0.31	0.52
MnO	0.170	0.002	84	0.009	0.41
MgO	10.68	0.07	84	0.30	0.71
CaO	12.90	0.06	84	0.35	0.51
Na₂O	1.73	0.03	82	0.06	1.32

Table 3 – Part 2					
Certified Values					
	Iceland Tholeiitic Basalt, BNA-1				
BNA-1	Certified Value X _{pt}	Uncertainty certified value (U)	Number reported results p	Horwitz Target Uncertainty (U)	Quality Factor
	mg / kg	mg / kg		mg / kg	
Ba Be Ce	6.1 0.09 1.76	0.5 0.01 0.08	57 25 49	0.7 0.02 0.26	1.66 1.36 0.94
Co Cu	55.6 112	1.2 3	68 74	4.9 9	0.72 0.74
Dy Er	2.40 1.62	0.05 0.05	47 48	0.34 0.24	0.40 0.52
Eu Ga	0.490 15.1	0.011 0.4	47 57	0.087 1.6	0.35 0.59
Gd Hf	1.73 0.56	0.05 0.03	47 43	0.26 0.10	0.58 0.70
Ho La	0.540 0.560	0.011 0.014	46 50	0.095 0.098	0.35 0.41
Li Lu	3.0 0.235	0.3 0.005	32 46	0.4	1.80 0.32
Na Ni Dr	2.23	0.09 9 0.019	51 74	0.32 16	0.78
SC Sm	42.1	0.018	45 62 49	3.8 0.17	0.82
Sr Ta	106	2	43 78 31	8	0.44 0.48 0.86
Tb	0.340	0.000	46 44	0.064	0.50
V	300 14 2	7 0 3	 77 68	20 1 5	0.55 0.92
Yb 7n	1.56	0.03	49 76	0.23	0.39
Zn	13.8	0.6	64	1.5	1.21

U is the uncertainty expanded to a 95% confidence limit.

Quality Factor data were calculated from unrounded data.

Table 4					
Indicative Values					
Iceland Tholeiitic Basalt, BNA-1					
BNA-1	Information Value X _{pt}	Uncertainty information value (U)	Number reported results p	Horwitz Target Uncertainty (U)	Quality Factor
	g/100g	g/100g		g /100g	
Fe(II)O	8.07	0.14	10	0.24	1.71
	mg / kg	mg / kg		mg / kg	
Ag	0.031	0.005	15	0.008	1.64
Cd	0.099	0.022	26	0.022	2.94
Cr	534	30	75	33	2.66
Ge	1.34	0.13	24	0.21	1.89
In	0.051	0.002	9	0.013	0.37
Мо	0.15	0.03	25	0.03	2.79
Nb	0.52	0.07	44	0.09	2.16
Pb	0.12	0.03	36	0.03	3.41
Rb	0.19	0.03	42	0.04	2.34
Sn	0.30	0.05	23	0.06	2.34
Th	0.025	0.008	37	0.007	3.23
U	0.008	0.003	28	0.003	3.33
W	0.23	0.03	25	0.05	1.74

U is the uncertainty expanded to a 95% confidence limit.

Quality Factor data were calculated from unrounded data.

Quality factors

Quality factors, derived according to procedures in Potts and Webb (2022), and listed in Tables 3 and 4 are designed to give an indication of the reliability of certified values in assessing measurement results in routine geochemical analysis. Briefly, a quality factor of 1 or less indicates that the uncertainty in the certified value is at least three times smaller than the uncertainty expected of a laboratory operating to the higher data quality 1 performance standard in the GeoPT programme (IAG 2020). In these circumstances, the certified value uncertainty will not be a significant factor when assessing data quality performance. Where the QF exceeds 1, uncertainty in the certified value will have an increasing effect on the assessment of geoanalytical performance (Potts and Webb 2022).

Instructions for handling

Certified values are for total mass fractions of oxides and elements, reported on a dry weight basis. Prior to use test portions should be dried at 105 °C for 2 hours before weighing. Alternatively, moisture content may be determined on a second test portion, the results from which can be used to correct to a dry weight. Rehomogenisation by manual shaking of the closed bottle is recommended before a sub-sample is taken.

Minimum sample mass

The recommended minimum sample test portion mass is 250 mg, as used in the homogeneity study. However, it was noted that a significant number of the GeoPT54 participating laboratories provided measurement results based on ≤ 100 mg test portions. An analysis of these results gave no evidence against taking 100 mg portions so long as the instructions in this certificate are followed.

Storage information

The CRM should be stored at room temperature and tightly sealed to protect it from absorption of atmospheric moisture and laboratory chemicals.

Period of validity

Provided the storage and handling conditions are met, this reference material is not expected to deteriorate with time. Consequently, the nominal period of validity of this certificate is selected as 20 years from the date of certification. On exposure to air, the material may absorb moisture, and instructions for handling to remove absorbed water before use of the material must be followed.

Metrological traceability

Certified values in IAG BNA-1 (Iceland Tholeiitic Basalt) are traceable according to the GeoPT certification protocol, which claims traceability based on: (i) Consensus values derived from a rigorous assessment using robust statistical procedures of all measurement results submitted to GeoPT54, noting that a significant proportion of these laboratories are accredited to ISO/IEC 17025 (2017). (ii) The synchronous measurement by participating laboratories of an established CRM (BRP-1 - Basalt Ribeirão Preto),) with a satisfactory evaluation of the equivalence between resultant GeoPT54A consensus values and corresponding certified values. (iii) Evidence from previous performance of the GeoPT programme when certified reference materials were used as test materials which has demonstrated the absence of statistically significant bias in GeoPT consensus values (see Potts et al., 2015).

Certification characterisation report

Further details of the procedures used, the results, their statistical analysis and data assessment, on which the property values listed in this certificate are based, can be found in the IAG BNA-1 certification report (Potts et al. 2025).

Safety information

Silicate powders can cause harm especially if ingested or in contact with the skin. User organisations must undertake a health and safety risk assessment and ensure that the appropriate procedures are followed in the handling and use of this material. Further details may be found on the relevant material safety data sheet.

Legal notice - terms and conditions

- 1. The IAG shall not be liable to the user of this material for loss (whether direct or indirect) of profits, business, anticipated savings or reputation or for any indirect or consequential loss or damage whatsoever even if previously advised thereof and whether arising from negligence, breach of these Terms and Conditions or howsoever occurring.
- 2. In any event, and notwithstanding anything contained in these Terms and Conditions, IAG's liability in contract, tort (including negligence, defamation, or breach of statutory duty) or otherwise arising by reason of or in connection with these Terms and Conditions (including as a result of proficiency testing) shall be limited to the price paid for the material giving rise to such liability.
- 3. The IAG does not grant any warranties in relation to Geo*PT* products or the supply of analytical services or distribution of the proficiency test, and all other conditions, warranties, stipulations, or other statements whatsoever, whether express or implied, by statute, at common law or otherwise howsoever, relating to the Geo*PT* products, analytical services or proficiency tests are hereby excluded. In particular, (but without limitation to the foregoing) no warranties are granted regarding the fitness for purpose, performance, use, quality, or merchantability of the Geo*PT* products, whether express or implied, by statute, at common law or otherwise howsoever.

Revisions

This certificate is version 1.00. Any further revisions to this Reference Material Certificate will be made available on the IAGeo Ltd web site (www.iageo.com).

Acknowledgements

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Approvals

This Certificate of Analysis was approved on behalf of the International Association of Geoanalysts follows:

Name Prof Dorrit Jacob	Position President of the International Association of Geoanalysts	Date: 15 April 2025
Name Prof Phil Potts	Position Director of the GeoPT Certification Programme	Date: 15 April 2025
Name Dr Peter Webb	Position Director of the GeoPT Proficiency Testing Programme	Date: 15 April 2025

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