# Preliminary data on mineral standards Basel-Ib (Biotite) and -Ih (Hornblende)

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# Preliminary Data on Mineral Standards Basel-1b (Biotite) and -1h (Hornblende)

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With 2 tables

Since the distribution of the famous rock standards G-1 and W-1, some 25 years ago, quite a number of new silicate rock standards became analyzed by laboratories working on geological samples.

Silicate mineral standards are of special interest because of their natural homogeneity, but came into circulation much later–large quantities of pure mineral (with interesting chemical composition) being quite hard available.

1963, the Mineralogical Institutes of Basle and Berne/Switzerland, started the distribution of a standard biotite and hornblende; 1973 an anorthoclase[1]) went under preparation:

| standard | mother rock | locality | literature |
|---|---|---|---|
| biotite | monomineralic aggregate | Val Agro | WENK et al. |
| Basel 1-b | in biotite schist | Ticino | (1963) |
| hornblende | hornblendite | R. del Motto | WENK et al. |
| Basel 1-h | | Finero | (1974) |
| anorthoclase | loose crystals from | Mt. Kibo | STERN (1969) |
| Basel 1-a | Kibo rhombporphyry | Kilimanjaro | |

The first two samples were sent – upon request – to nearly 100 laboratories all over the world; by 1974 18 different laboratories had contributed chemical data (see table 1).

For reasons of economy, not all analyses are reported here in detail; tabulated, however, are the evaluation of the main constituents, and the original trace element values. Full data on main constituents may be ordered from the library of the Mineralogical Institute/University of Basle, Switzerland.

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[1]) Powdered samples are delivered by the Geochemical Laboratory, Bernoullistrasse 30, CH-4056 Basle, Switzerland.

Table 1. *List of participating organizations.*

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Gilkes, R. J., University Western Australia.
Glasser, Dr. F. P., University of Malaya, Kuala Lumpur, Malaysia.
Hügi, Prof. Th., Universität Bern, Switzerland.
Kleeman, A. W., University Adelaide, Australia.
Meisl, Dr. St., Hess. Landesamt für Bodenforschung, BRD.
Neiva, Prof. C. J. H., Universidade de Coimbra, Portugal.
Otto, Dr. J. and Czygan, Dr. W., Universität Freiburg i. Br., BRD.
Poole, Dr. A. B., Queen Mary College, University of London, UK.
Randall, B. A. O., University New Castle upon Tyne, UK.
Randle, Dr. K., Scott. Research Centre, East Kilbridge, Glasgow, UK.
Richter, Dr. P., Universität Würzburg, BRD.
Schmidt, Prof., Zentr. Geol. Institut, Berlin, DDR.
Schwander, Prof. H., Universität Basel, Switzerland.
Thompson, Dr. G., Woods Hole Oceanogr. Institute, Woods Hole, Mass., USA.
Troll, Dr. G., Universität München, BRD.
US Geological Survey, Washington, USA.
Weibel, Prof. M., ETH, Zürich, Switzerland.

In a first step all chemical data on main constituents were collected, the averages, standard deviations, and coefficients of variation calculated; in a second step only those values falling in between the $\pm 1\ \sigma$ range of the first evaluation became considered. Again, averages, standard deviations, and coefficients of variation were calculated, see table 2a. From these data, the «recommanded values» are derived. The second decimal digit is only given in case of sufficiently small coefficients of variation. Less reliable data stand in between brackets.

Especially in case of minerals, informations about the trace elements are of interest: one may assume, that the scattering of data is principally due to analytical error, rather than to natural inhomogeneities of the specimen. The "recommended values" for the reported trace elements have to be regarded as rough estimations only, informations yet being too scarce.

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Table 2a.

*Evaluation: Mineral Standard Basel-1b (biotite)*

| | *A. All values considered* | | | | *B. Values in between 1 σ ± considered* | | | | *C. Recommanded values* |
|---|---|---|---|---|---|---|---|---|---|
| | N | Average wt-% | Standard deviation | Coeff. of variation | N | Average wt-% | Standard deviation | Coeff. of variation | wt-% |
| $SiO_2$ | 15 | 37.36 | 1.01 | 5.8 | 13 | 37.53 | 0.41 | 1.1 | 37.5 |
| $Al_2O_3$ | 15 | 17.28 | 0.53 | 3.1 | 10 | 17.23 | 0.27 | 1.6 | 17.25 |
| $Fe_2O_3$ | 10 | 1.74 | 0.43 | 24.7 | 6 | 1.76 | 0.18 | 10.2 | 1.75 |
| FeO | 9 | 10.63 | 0.38 | 3.6 | 8 | 10.52 | 0.25 | 2.4 | 10.5 |
| MnO | 17 | 0.09 | 0.02 | 22.1 | 16 | 0.09 | 0.01 | 11.1 | 0.09 |
| MgO | 14 | 16.32 | 0.69 | 4.2 | 11 | 16.23 | 0.45 | 2.8 | 16.2 |
| CaO | 14 | 0.09 | 0.08 | 89 | 11 | 0.07 | 0.03 | 43 | (0.07) |
| $Na_2O$ | 13 | 0.38 | 0.09 | 23.7 | 9 | 0.36 | 0.05 | 13.9 | 0.36 |
| $K_2O$ | 17 | 9.15 | 0.20 | 2.2 | 12 | 9.11 | 0.11 | 1.2 | 9.1 |
| $TiO_2$ | 13 | 2.41 | 0.25 | 10.4 | 11 | 2.50 | 0.08 | 3.2 | 2.50 |
| $P_2O_5$ | 4 | 0.04 | 0.04 | 100 | | | | | (0.04) |
| $H_2O^+$ | 5 | 3.62 | 0.45 | 12.4 | 4 | 3.75 | 0.38 | 10.1 | 3.75 |
| $H_2O^-$ | 6 | 0.43 | 0.24 | 56 | 4 | 0.28 | 0.12 | 43 | (0.28) |
| | | | | | | | | | 99.39 |
| $Fe_2O_{3\,tot}$ | 13 | 13.56 | 0.22 | 1.6 | 9 | 13.47 | 0.15 | 1.1 | 13.45 |
| $H_2O_{tot}$ | 4 | 3.47 | 0.69 | 19.9 | 3 | 3.17 | 0.40 | 12.6 | 3.2 |
| | *Mineral Standard Basel-1h (hornblende)* | | | | | | | | |
| $SiO_2$ | 11 | 43.29 | 0.77 | 1.8 | 7 | 43.29 | 0.47 | 1.1 | 43.3 |
| $Al_2O_3$ | 13 | 15.62 | 0.52 | 3.3 | 9 | 15.66 | 0.30 | 1.9 | 15.65 |
| $Fe_2O_3$ | 7 | 1.07 | 0.28 | 26.2 | 5 | 1.20 | 0.21 | 17.5 | 1.2 |
| FeO | 7 | 5.68 | 0.48 | 8.5 | 5 | 5.59 | 0.14 | 2.5 | 5.6 |
| MnO | 13 | 0.10 | 0.01 | 10.0 | 8 | 0.10 | 0.005 | 5.0 | 0.10 |
| MgO | 11 | 16.80 | 0.89 | 5.3 | 9 | 16.74 | 0.58 | 3.5 | 16.75 |
| CaO | 13 | 11.72 | 0.18 | 1.5 | 10 | 11.71 | 0.09 | 0.8 | 11.70 |
| $Na_2O$ | 10 | 2.52 | 0.16 | 6.4 | 8 | 2.55 | 0.10 | 3.9 | 2.55 |
| $K_2O$ | 13 | 0.28 | 0.07 | 25.0 | 9 | 0.28 | 0.04 | 14.3 | 0.3 |
| $TiO_2$ | 10 | 0.32 | 0.05 | 15.6 | 7 | 0.30 | 0.01 | 4.3 | 0.30 |
| $P_2O_5$ | 6 | 0.02 | 0.03 | 150 | | | | | (0.02) |
| $H_2O^+$ | 3 | 2.13 | 0.31 | 14.6 | 2 | 2.31 | | | 2.3 |
| $H_2O^-$ | 4 | 0.11 | 0.07 | 64 | 3 | 0.08 | 0.03 | 37.5 | 0.1 |
| | | | | | | | | | 99.87 |
| $Fe_2O_{3\,tot}$ | 12 | 7.39 | 0.38 | 5.1 | 8 | 7.32 | 0.21 | 2.9 | 7.3 |
| $H_2O_{tot}$ | 6 | 2.39 | 0.30 | 12.6 | 5 | 2.49 | 0.17 | 6.8 | 2.5 |

*Mineral Standard Basel-1a (anorthoclase)* *Tentative values*

| | |
|---|---|
| $SiO_2$ | 60.6 |
| $Al_2O_3$ | 21.8 |
| $Fe_2O_{3\,tot}$ | 1.6 |
| MgO | 0.2 |
| CaO | 2.7 |
| $Na_2O$ | 6.9 |
| $K_2O$ | 4.1 |
| $TiO_2$ | 0.4 |
| $H_2O$ | 0.8 |
| Sum | 99.1 |

Table 2b.

*Trace elements of mineral standards Basel-1b and Basel-1h (ppm)*

| Elements | *Basel-1b* (biotite) | Tentative Value | *Basel-1h* (Hornblende) | Tentative Value |
|---|---|---|---|---|
| Li | 105, 90, 105, 115, 73 | 100 | 13, 10, 10 | 10 |
| Be | <5, 4.9, <10 | 5 | <1, <1 | <1 |
| B | <10, <5, <5 | <5 | <10, 5, <5 | 5 |
| F | 3000 | (3000) | 100 | (100) |
| Cl | 400 | (400) | 300 | (300) |
| Sc | 50, 40.0, 52, 85, 30 | 50 | 30, 31.7, 30 | 30 |
| V | 70, 120, 138, 320, 400 | 200 | 245, 150, 240, 430 | 250 |
| Cr | 1000, >500, 820, 1200, >1200, 1000, 855, 930 | 1000 | 875, 700, 820, 650, 1700, 800, 760, 720 | 800 |
| Co | 100, 90, 58, 69, 65, 53, 110 | 70 | 45, 30, 50, 70, 60, 75 | 60 |
| Ni | 1000, >400, 2080, 665, 880, 650 | 850 | 240, 200, 255, 300, 380 | 250 |
| Cu | 30, 3, 3, 65, <10 | <10 | 30, 30, 20, 35, <10 | 30 |
| Zn | 180, 300, 135, 235, 240 | 210 | <40, 35, 65 | 35 |
| Ga | 50, 17, 30, 59 | 40 | 10, <5, 12 | 10 |
| Ge | 50 | (50) | 30 | (30) |
| Rb | 590, 570, >1000, 360 | 600 | 12, 30, <10, <10 | 10 |
| Sr | 10, 30, 10, <10 | 10 | 245, 300, 210, 200, 250, 265 | 250 |
| Y | 20, 7 | 15 | 15, 10 | 15 |
| Zr | 160, <200, <30, 36, <1 | 10 | 65, <30, 11 | 15 |
| Nb | 30, 95 | 50 | | |
| Mo | 1.5, 22, <1, <10 | <10 | 4, <10 | 5 |
| Ag | <1 | (<1) | <1 | (<1) |
| Cd | <2 | (<2) | <2 | (<2) |
| Sn | 15, 15, 162 | 15 | 5 | (5) |
| Sb | 3 | (3) | <0.3 | (<0.3) |
| Cs | 23.5, <30 | 24 | <1 | (<1) |
| Ba | 1100, 1000, 980, 860, >1200, 965, 1500 | 1000 | 30, 30, <100, 25, 65, 50 | 30 |
| La | 50, 38.7 | 40 | 26.4 | (26) |
| Ce | 88 | (88) | 14 | (14) |
| Nd | 52 | (52) | 18 | (18) |
| Sm | 10.5 | (11) | 9.0 | (9) |
| Eu | 0.27 | (0.3) | 0.44 | (0.4) |
| Yb | 2 | (2) | | |
| Lu | <0.1 | (<0.1) | 0.20 | (0.2) |
| Hf | 1.0 | (1) | 0.61 | (0.6) |
| Ta | 4.2 | (4) | <0.2 | (<0.2) |
| Tl | <20 | (<20) | | |
| Pb | 15, <10, 10, <2, 15 | 10 | 10, <5, 2, 25 | 10 |
| Bi | <2 | (<2) | <2 | (<2) |
| Th | 15.6 | (16) | <0.8 | (<0.8) |
| U | <10 | (<10) | <10 | (<10) |

When only one analysis is given, the recommended value is printed between brackets. The data are presented in chronological order (eldest to the left).

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