**DATA REPOSITORY 2015108**

**METHODOLOGY ON MAJOR AND TRACE ELEMENT ANALYSIS**

Samples were crushed and powdered by jaw crusher and corundum mill. The samples were then fused into glass beads. Major elements of samples were given by the **X**-**R**ay **F**luorescence (XRF) analytical results of these glass beads using Rigaku® RIX-2000 spectrometer in the Department of Geosciences, National University of Taiwan. The analytical procedures mentioned in Wang *et al.* (2004) were adopted in this paper, while the **L**oss **O**f **I**gnition (LOI) was determined separately by routine procedures. The glass beads were then crushed, weighed for ~40 mg and digested by $HNO_3$ (1:1) and super-pure HF in Teflon® beakers at 100 °C for 2 hours. The digested samples were then evaporated to dryness, and then digested by $HNO_3$ (1:2) at 100 °C again overnight. Internal standard solution of 10 ppb Rh and Bi in 2% $HNO_3$ was added. The sample solutions were diluted by 2% $HNO_3$ by 1500 times after all. The sample solutions were then ready for analysis by **I**nductively **C**oupled **P**lasma – **M**ass **S**pectrometry (ICP-MS) technique using an Agilent 7500cx spectrometer also in the Department of Geosciences, National Taiwan University. The precision of the result is generally within ±5% (2σ). The external standard used in the analyses were USGS standards AGV-2, BHVO-2 and BCR-2.

Partition coefficient (Kd) of elements in particular mineral in high silica rhyolite

| Kd | Hornblende (Ewart and Griffin, 1994) | Biotite (Mahood and Hildreth, 1983) | Plagioclase (Ewart and Griffin, 1994) | K-feldspar (Ewart and Griffin, 1994) |
|---|---|---|---|---|
| Ba | 4.50 | 3.70 | 1.80 | 2.70 |
| Fe | 21.0 | 59.1 | 0.12 | 0.85 |
| Nb | 0.76 | 0.47 | 0.16 | 0.21 |
| Rb | 0.046 | 5.30 | 0.029 | 0.72 |
| Sr | 0.77 | 7.20 | 4.04 | 2.11 |
| Zr | 4.20 | 9.10 | 0.27 | 0.16 |

## Recommended values of the USGS andesite standard AGV-2

| Element | wt% | ± | Oxide | wt % | ± |
|---|---|---|---|---|---|
| Al | 8.95 | 0.11 | $Al_2O_3$ | 16.91 | 0.21 |
| Ca | 3.72 | 0.09 | CaO | 5.20 | 0.13 |
| Fe | 4.68 | 0.09 | $Fe_2O_3$ | 6.69 | 0.13 |
| K | 2.39 | 0.09 | $K_2O$ | 2.88 | 0.11 |
| Mg | 1.08 | 0.02 | MgO | 1.79 | 0.03 |
| Na | 3.11 | 0.09 | $Na_2O$ | 4.19 | 0.13 |
| P | 0.21 | 0.01 | $P_2O_5$ | 0.48 | 0.02 |
| Si | 27.7 | 0.35 | $SiO_2$ | 59.3 | 0.7 |
| Ti | 0.63 | 0.13 | $TiO_2$ | 1.05 | 0.22 |

| Element | µg/g | ± | Element | µg/g | ± |
|---|---|---|---|---|---|
| Ba | 1140 | 32 | Pb | 13 | 1 |
| Be | 2.3 | 0.4 | Pr | 8.3 | 0.6 |
| Ce | 68 | 3 | Rb | 68.6 | 2.3 |
| Co | 16 | 1 | Sc | 13 | 1 |
| Cr | 17 | 2 | Sr | 658 | 17 |
| Cu | 53 | 4 | Th | 6.1 | 0.6 |
| Dy | 3.6 | 0.2 | U | 120 | 5 |
| La | 38 | 1 | Y | 20 | 1 |
| Mn | 770 | 20 | Yb | 1.6 | 0.2 |
| Nb | 15 | 1 | Zn | 86 | 8 |
| Nd | 30 | 2 | Zr | 230 | 4 |
| Ni | 19 | 3 | | | |

## Information values of the USGS andesite standard AGV2

| Element | µg/g | ± | Element | µg/g | ± |
|---|---|---|---|---|---|
| Cs | 1.16 | 0.08 | Lu | 0.25 | 0.01 |
| Er | 1.79 | 0.11 | Sb | 0.6 | |
| Eu | 1.54 | 0.10 | Sm | 5.7 | 0.3 |
| F | 440 | | Sn | 2.3 | 0.4 |
| Gd | 4.69 | 0.26 | Ta | 0.89 | 0.08 |
| Hf | 5.08 | 0.20 | Tb | 0.64 | 0.04 |
| Ho | 0.71 | 0.08 | Tl | 0.27 | |
| Li | 11 | | Tm | 0.26 | 0.02 |

Recommended values of the USGS basalt (Hawaiian Volcanic Observatory) standard BHVO-2

| Element | wt% | ± | Oxide | wt % | ± |
|---|---|---|---|---|---|
| Al | 7.16 | 0.08 | $Al_2O_3$ | 13.5 | 0.2 |
| Ca | 8.17 | 0.12 | CaO | 11.4 | 0.2 |
| $Fe_{tot}$ | 8.63 | 0.14 | $Fe_2O_{3tot}$ | 12.3 | 0.2 |
| K | 0.43 | 0.01 | $K_2O$ | 0.52 | 0.01 |
| Mg | 4.36 | 0.07 | MgO | 7.23 | 0.12 |
| Na | 1.64 | 0.06 | $Na_2O$ | 2.22 | 0.08 |
| P | 0.12 | 0.01 | $P_2O_5$ | 0.27 | 0.02 |
| Si | 23.3 | 0.3 | $SiO_2$ | 49.9 | 0.6 |
| Ti | 1.63 | 0.2 | $TiO_2$ | 2.73 | 0.04 |

| Element | µg/g | ± | Element | µg/g | ± |
|---|---|---|---|---|---|
| Ba | 130 | 13 | Nd | 25.0 | 1.8 |
| Ce | 38 | 2 | Ni | 119 | 7 |
| Co | 45 | 3 | Rb | 9.8 | 1.0 |
| Cr | 280 | 19 | Sc | 32 | 1 |
| Cu | 127 | 7 | Sr | 389 | 23 |
| Ga | 21.7 | 0.9 | V | 317 | 11 |
| Hf | 4.1 | 0.3 | Y | 26 | 2 |
| La | 15 | 1 | Zn | 103 | 6 |
| Mn | 1290 | 40 | Zr | 172 | 11 |

Information values of the USGS basalt (Hawaiian Volcanic Observatory) standard BHVO-2

| Element | µg/g | ± | Element | µg/g | ± |
|---|---|---|---|---|---|
| F | 370 | | Sm | 6.2 | 0.4 |
| Gd | 6.3 | 0.2 | Sn | 1.9 | |
| Ho | 1.04 | 0.04 | Ta | 1.4 | |
| Li | 5 | | Tb | 0.9 | |
| Lu | 0.28 | 0.01 | Th | 1.2 | 0.3 |
| Nb | 18 | 2 | Yb | 2.0 | 0.2 |

Recommended values of the USGS basalt (Columbia River) standard BCR-2

| Element | wt% | ± | Oxide | wt % | ± |
|---|---|---|---|---|---|
| Al | 7.14 | 0.10 | $Al_2O_3$ | 13.5 | 0.2 |
| Ca | 5.09 | 0.08 | CaO | 7.12 | 0.11 |
| $Fe_{tot}$ | 9.66 | 0.15 | $Fe_2O_{3tot}$ | 13.8 | 0.2 |
| K | 1.49 | 0.04 | $K_2O$ | 1.79 | 0.05 |
| Mg | 21.6 | 0.03 | MgO | 3.59 | 0.05 |
| Na | 2.34 | 0.08 | $Na_2O$ | 3.16 | 0.11 |
| P | 0.15 | 0.01 | $P_2O_5$ | 0.35 | 0.02 |
| Si | 25.3 | 0.4 | $SiO_2$ | 54.1 | 0.8 |
| Ti | 1.35 | 0.03 | $TiO_2$ | 2.26 | 0.05 |

| Element | µg/g | ± | Element | µg/g | ± |
|---|---|---|---|---|---|
| Ba | 683 | 28 | Rb | 48 | 2 |
| Ce | 53 | 2 | Sc | 33 | 2 |
| Co | 37 | 3 | Sr | 346 | 14 |
| Cr | 18 | 2 | Th | 6.2 | 0.7 |
| Eu | 2.0 | 0.1 | U | 1.69 | 0.19 |
| Ga | 23 | 2 | V | 416 | 14 |
| Gd | 6.8 | 0.3 | Y | 37 | 2 |
| La | 25 | 1 | Yb | 3.5 | 0.2 |
| Mn | 1520 | 60 | Zn | 127 | 9 |
| Mo | 248 | 17 | Zr | 188 | 16 |
| Nd | 28 | 2 | | | |

Information values of the USGS basalt (Columbia River) standard BCR-2

| Element | µg/g | ± | Element | µg/g | ± |
|---|---|---|---|---|---|
| Cs | 1.1 | 0.1 | Lu | 0.51 | 0.02 |
| Cu | 19 | 2 | Pb | 11 | 2 |
| F | 440 | | Pr | 6.8 | 0.3 |
| Hf | 4.8 | 0.2 | Sm | 6.7 | 0.3 |
| Ho | 1.33 | 0.06 | Tb | 1.07 | 0.04 |
| Li | 9 | 2 | Tm | 0.54 | |

**METHODOLOGY ON Sr-Nd ISOTOPE ANALYSIS**

Powdered samples were weighed for ~80 mg and digested by $HNO_3$ (1:1) and super-pure HF in 15 mL screw-top Savillex® beakers for 5 days at ~150 °C. The samples were then evaporated to dryness. The samples were then dissolved by 2 mL 4N HCl and 1N HCl, and then put into centrifugal separation. Sr and **R**are **E**arth **E**lements (REE) were isolated from the sample solution and passed through an AG50W-X8 cation-exchange column filled with 100-200 mesh resins produced by Eichrom Industries, Inc, which can selectively extract Sr and REE respectively. Nd fractions were further separated from the REE portion and were purified using LN resin. HCl was used as eluent. Once separated, the Sr and Nd fractions were loaded with a Ta-HF activator on a single W filament and a Re double filament assembly respectively for measurements. The measurements of isotope data rely on **M**ulti-**C**ollector **I**nductively **C**oupled **P**lasma **M**ass **S**pectrometry (MC-ICP-MS), using the Thermo Electron Finnigan™ Naptune in the Department of Geosciences, National Taiwan University. Measured $^{87}Sr/^{86}Sr$ and $^{146}Nd/^{144}Nd$ were then normalized to 0.1194 and 0.7219 respectively for mass fractionation. SRM (NBS) 987 and JNdi-1 were used as Sr and Nd standards during data acquisition. The measured values for $^{87}Sr/^{86}Sr$ and $^{143}Nd/^{144}Nd$ were 0.710287 and 0.512095 respectively.

Recommended values for SRM (NBS) 987 and JNdi-1

| Reference | $^{87}Sr/^{86}Sr$ | Reference | $^{143}Nd/^{144}Nd$ |
|---|---|---|---|
| SRM (NBS) 987 | 0.710250 | JNdi-1 | 0.512100 |