**This Supplementary Material accompanies the article:**

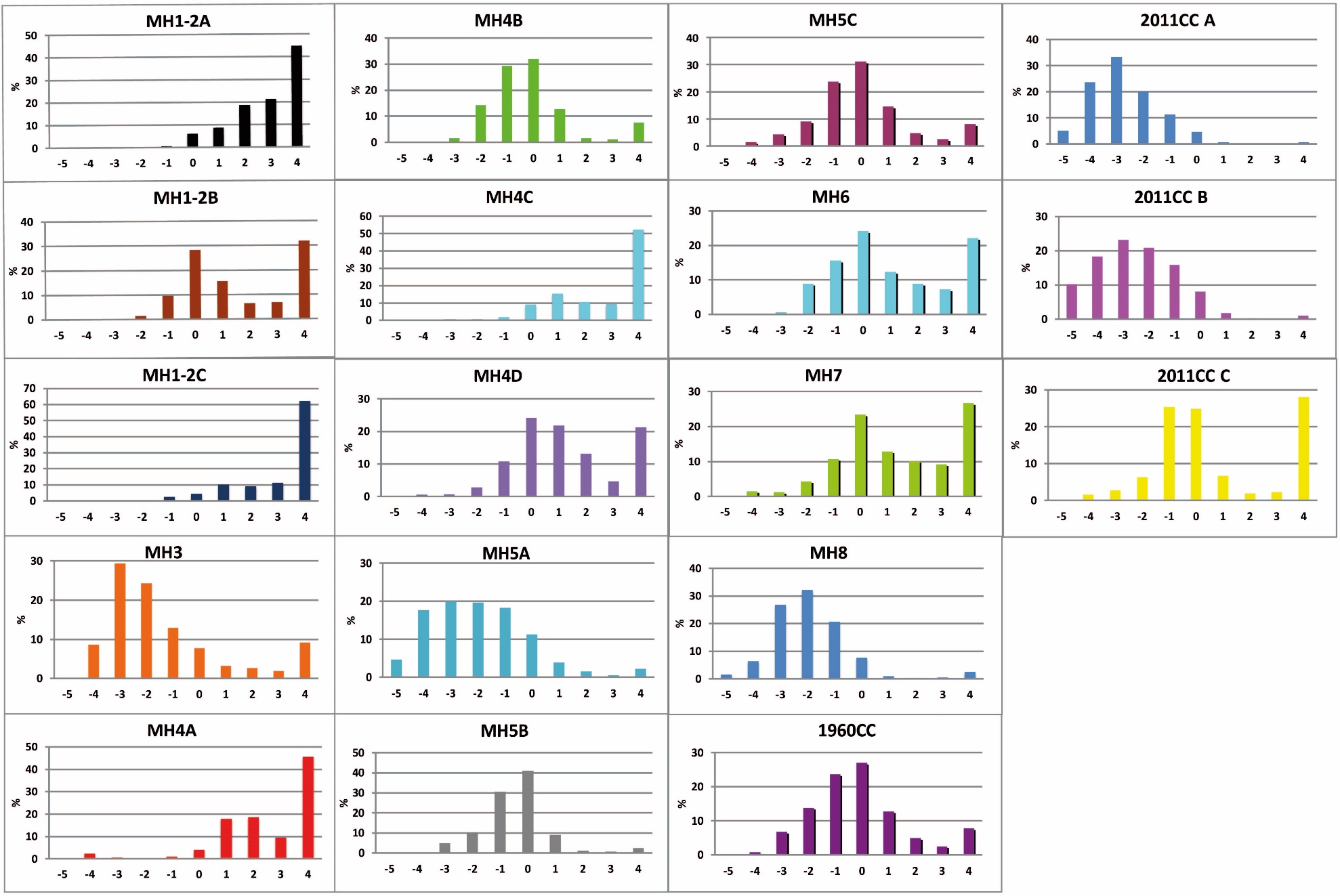
Alfonzo, W. A., Daga, R., Demichelis, A., Goldmann, G., and Ribeiro Guevara, S. (2025) “Textural complexity and geochemistry on the last millennium pyroclastic deposits from Puyehue-Cordón Caulle Volcanic Complex: implications for tephrochronological and volcanological interpretations”, *Volcanica*, 8(1), pp. 111–134. doi: 10.30909/vol.08.01.111134.

**Alfonzo et al. [2025] should be cited if these materials are used.**

**Table S1. Granulometric features and componentry analyses from 2011CC, 1960CC and MH Units.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Layer | | Subdivision | Thickness (cm) | Grain size (%) | | | Mode fraction (ϕ) | Componentry (%) | | | | | | | |
| Lapilli | Coarse Ash | Fine Ash | White  pum | Brown  pum | Brown Glass | Scoria | Obsidian | Crystals | Lithics |
| 2011CC | 2011CC | C | 12 | 10.6 | 61.3 | 28.1 | -1\* | 98.1 | 0 | 0 | 1.9 | 0 | 0 | 0 |
| B | 30 | 72.7 | 26.2 | 1.0 | -3 | 93.9 | 0 | 0 | 5.7 | 0.4 | 0 | 0 |
| A | 82.2 | 17.0 | 0.7 | -3 | 98.5 | 0 | 0 | 0 | 1.5 | 0 | 0 |
| 1960CC | 1960CC |  | 6 | 21.3 | 70.9 | 7.8 | 0 | 50.9 | 0.5 | 0 | 26.2 | 0 | 22.4 | 0.5 |
| MH | MH8 |  | 14 | 67.1 | 30.3 | 2.6 | -2 | 95.2 | 0 | 0 | 0 | 4.3 | 0 | 0.5 |
| MH7 |  | 9 | 7.1 | 66.3 | 26.7 | 0\* | 41.7 | 0 | 1.7 | 3 | 33.6 | 10.6 | 9.4 |
| MH6 |  | 3 | 9.5 | 68.5 | 22.1 | 0 | 30.3 | 0 | 0 | 1 | 49.5 | 8.2 | 11.1 |
| MH5 | C | 2 | 14.9 | 77.0 | 8.1 | 0 | 29.7 | 0 | 0 | 0 | 50.2 | 0 | 20.1 |
| B | 2 | 15.3 | 82.2 | 2.5 | 0 | 37.8 | 2.1 | 0 | 0 | 54.9 | 4.3 | 0.9 |
| A | 12 | 62.0 | 35.7 | 2.3 | -3 | 82.8 | 0 | 0 | 0 | 13.4 | 0 | 3.8 |
| MH4 | D | 10 | 4.0 | 74.8 | 21.2 | 0 | 4.5 | 0 | 1.3 | 0 | 64.3 | 29 | 0.9 |
| C | 1 | 1.2 | 46.6 | 52.3 | 1\* | 6.6 | 3.8 | 0 | 0 | 63.4 | 24.9 | 1.9 |
| B | 2 | 15.7 | 76.8 | 7.5 | 0 | 95.9 | 0 | 0 | 0 | 4.1 | 0 | 0 |
| A | 2 | 3.1 | 51.4 | 45.5 | 2\* | 0 | 0 | 3.5 | 0 | 85.8 | 10.6 | 0 |
| MH3 |  | 8 | 62.3 | 28.5 | 9.2 | -3 | 100 | 0 | 0 | 0 | 0 | 0 | 0 |
| MH1-2 | C | 2 | 0.2 | 37.7 | 62.1 | 3\* | 0 | 0 | 36.6 | 0 | 29.2 | 25.7 | 8.4 |
| B | 3 | 1.5 | 66.7 | 31.8 | 0\* | 51.4 | 0 | 9.4 | 0 | 26.9 | 11.8 | 0 |
| A | 1 | 0.0 | 55.4 | 44.6 | -3\* | 0 | 0 | 75.8 | 0 | 12.5 | 3.8 | 7.9 |

**\*Second Mode, when first Mode corresponded to 4 ϕ.**

 **Figure S1. Granulometric distribution of 2011CC, 1960 and MH Units.**

**Table S2. Elemental analysis of Certified Reference Materials NIST 2709a San Joaquín Soil and IAEA soil 7.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **CRM NIST 2709a** | | CRM IAEA soil 7 | |
|  | **measured** | **certified** | **measured** | **certified** |
| **Al (wt%)** | 7.18 ± 0.20 | 7.37 ± 0.16 | 4.67 ± 0.14 | 4.7 ± 0.3\* |
| **Ti (wt%)** | 0.337 ± 0.032 | 0.336 ± 0.007 | 0.367 ± 0.040 | 0.30 ± 0.06 |
| **Fe (wt%)** | 3.41 ± 0.23 | 3.36 ± 0.07 | 2.52 ± 0.17 | 2.57 ± 0.05\* |
| **Mn (wt%)** | 0.0501 ± 0.0017 | 0.0529 ± 0.0018 | 0.0648 ± 0.0016 | 0.0631 ± 0.0023 |
| **Mg (wt%)** | 1.74 ± 0.11 | 1.46 ± 0.02 | 1.383 ± 0.093 | 1.13 ± 0.04\* |
| **Ca (wt%)** | 2.16 ± 0.58 | 1.91 ± 0.09 | 16.2 ± 1.3 | 16.3 ± 0.9\* |
| **Na (wt%)** | 1.254 ± 0.032 | 1.22 ± 0.03 | 0.2422 ± 0.0066 | 0.24 ± 0.01 |
| **K (wt%)** | 2.196 ± 0.076 | 2.11 ± 0.06 | 1.306 ± 0.053 | 1.21 ± 0.07\* |
| **Si (wt%)** | 33 ± 2\*\* | 30.3 ± 0.4 |  |  |
| **Rb (μg.g-1)** | 102.3 ± 4.9 | 99 ± 3 | 53.3 ± 2.6 | 51.0 ± 4.5 |
| **Ba (μg.g-1)** | 1060 ± 85 | 979 ± 28 | 165 ± 14 | 159 ± 33\* |
| **Cs (μg.g-1)** | 5.18 ± 0.29 | 5.0 ± 0.1 | 5.32 ± 0.31 | 5.4 ± 0.8 |
| **Hf (μg.g-1)** | - | - | 4.89 ± 0.25 | 5.1 ± 0.4 |
| **Ta (μg.g-1)** | - | - | 0.729 ± 0.048 | 0.8 ± 0.2 |
| **Th (μg.g-1)** | 10.01 ± 0.55 | 10.9 ± 0.2 | 7.77 ± 0.42 | 8.2 ± 1.1 |
| **U (μg.g-1)** | 3.68 ± 0.34 | 3.15 ± 0.05 | 2.51 ± 0.24 | 2.6 ± 0.6 |
| **Sb (μg.g-1)** | 1.60 ± 0.15 | 1.55 ± 0.06 | 1.73 ± 0.16 | 1.7 ± 0.2 |
| **Co (μg.g-1)** | 13.58 ± 0.64 | 12.8 ± 0.2 | 9.03 ± 0.42 | 8.9 ± 0.9 |
| **V (μg.g-1)** | 110.2 ± 4.4 | 110 ± 11 | 72.2 ± 3.9 | 66 ± 7 |
| **Ni (μg.g-1)** | 83.9 ± 6.5 | 85 ± 2 | 26.1 ± 2.2 | 26 ± 8 |
| **Cr (μg.g-1)** | 124.7 ± 7.8 | 130 ± 9 | 73.0 ± 4.0 | 60 ± 13 |
| **Sc (μg.g-1)** | 11.72 ± 0.60 | 11.1 ± 0.1 | 11.72 ± 0.60 | 8.3 ± 1.1 |
| **Sr (μg.g-1)** | 324 ± 59 | 239 ± 6 | 135 ± 28 | 108 ± 6 |
| **Zr (μg.g-1)** | 137 ± 28 | 195 ± 46 | 183 ± 19 | 185 ± 11 |
| **Zn (μg.g-1)** | 106.7 ± 6.7 | 103 ± 4 | 105.2 ± 6.7 | 104 ± 6 |
| **As (μg.g-1)** | 9.32 ± 0.58 | 10.5 ± 0.3 | 12.16 ± 0.73 | 13.4 ± 0.9 |
| **La (μg.g-1)** | 22.8 ± 1.1 | 21.7 ± 0.4 | 28.6 ± 1.4 | 28 ± 1 |
| **Ce (μg.g-1)** | 47.4 ± 4.1 | 42 ± 1 | 60.5 ± 5.6 | 61 ± 6.5 |
| **Nd (μg.g-1)** |  |  | 25.5 ± 2.8 | 30 ± 6 |
| **Sm (μg.g-1)** | - | - | 4.94 ± 0.39 | 5.1 ± 0.4 |
| **Eu (μg.g-1)** | 0.913 ± 0.049 | 0.830 ± 0.020 | 1.033 ± 0.055 | 1.0 ± 0.2 |
| **Tb (μg.g-1)** | - | - | 0.681 ± 0.037 | 0.6 ± 0.2 |
| **Dy (μg.g-1)** | - | - | 4.60 ± 0.46 | 3.9 ± 1.1 |
| **Yb (μg.g-1)** | - | - | 2.31 ± 0.25 | * 1. ± 0.4 |

**\*Informed values. \*\* Estimated by difference of oxides values**

**Table S3. Whole rock major and trace element composition of Cardenal Samoré tephras (measured by INAA). Oxides as wt % (SiO2 estimated by difference),**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Layer** | MH1-2 | | | | | MH3 | |
| **Sample** | ST1pb18 | ST1pb35 | ST1o35 | ST1o60 | ST1v60 | ST2pb3 | ST2o35 |
| **Type** | White pumice | White pumice | Obsidians | Obsidians | Glass shard | White pumice | Obsidians |
| **SiO2** | 67.7 | 67.8 | 68.0 | 66.3 | 65.2 | 64.5 | 65.7 |
| **Al2O3** | 14.10 | 13.83 | 13.66 | 14.34 | 14.11 | 16.42 | 14.51 |
| **TiO2** | 0.75 | 0.70 | 0.76 | 0.73 | 0.65 | 0.072 | 0.77 |
| **Fe2O3 (Total)** | 5.57 | 4.86 | 4.83 | 5.08 | 5.22 | 4.75 | 5.15 |
| **MgO** | 1.21 | 1.12 | 1.32 | 1.30 | 1.79 | 1.33 | 1.36 |
| **CaO** | 1.62 | 2.49 | 2.20 | 2.56 | 3.72 | 2.99 | 2.67 |
| **Na2O** | 5.05 | 5.14 | 5.18 | 5.47 | 5.28 | 5.20 | 5.54 |
| **K2O** | 2.79 | 2.90 | 2.86 | 3.00 | 2.82 | 2.96 | 3.17 |
| **MnO** | 0.11 | 0.11 | 0.11 | 0.11 | 0.12 | 0.11 | 0.12 |
| **Sc** | 14.44±0.74 | 14.13±0.72 | 15.34±0.79 | 15.31±0.80 | 15.91±0.82 | 14.36±0.76 | 15.32±0.79 |
| **V** | 26.1±2.9 | 20.3±3.0 | 20.8±2.3 | 25.7±3.5 | 38.3±2.9 | 17.4±4.1 | 24.3±3.3 |
| **Cr** | 4.31±0.73 | 3.33±0.92 | 3.72±0.76 | 6.9±1.4 | 9.31±0.98 | 2.37±0.66 | 6.44±0.98 |
| **Co** | 4.85±0.23 | 3.83±0.19 | 4.93±0.23 | 5.41±0.26 | 6.80±0.33 | 4.25±0.20 | 4.99±0.24 |
| **Zn** | 97.9±6.6 | 89.8±6.1 | 96.1±6.5 | 98.4±6.8 | 98.5±6.9 | 98.7±6.7 | 100.9±7.1 |
| **Rb** | 74.4±4.2 | 72.1±4.8 | 78.4±4.4 | 80.5±5.1 | 70.3±4.9 | 76.2±4.6 | 78.2±4.8 |
| **Sr** | 212±65 | 198±54 | 226±45 | 270±45 | 252±73 | 199±50 | 246±53 |
| **Cs** | 4.57±0.31 | 4.67±0.31 | 4.76±0.32 | 4.82±0.89 | 4.48±0.30 | 4.85±0.29 | 4.55±0.29 |
| **Ba** | 722±59 | 748±61 | 802±72 | 762±68 | 705±72 | 748±60 | 732±59 |
| **Zr** | 341±66 | 351±84 | 360±49 | 169±71 | 372±91 | 344±53 | 278±67 |
| **Hf** | 9.60±0.48 | 9.58±0.50 | 9.69±0.48 | 9.75±0.50 | 9.00±0.47 | 9.85±0.50 | 9.40±0.48 |
| **Ta** | 0.615±0.039 | 0.531±0.040 | 0.587±0.045 | 0.599±0.043 | 0.498±0.037 | 0.580±0.037 | 0.567±0.042 |
| **Th** | 8.85±0.44 | 8.97±0.47 | 9.19±0.50 | 9.08±0.46 | 8.00±0.44 | 8.92±0.45 | 8.62±0.42 |
| **Sb** | 1.13±0.11 | 0.998±0.098 | 0.949±0.098 | 0.937±0.091 | 0.827±0.091 | 0.879±0.096 | 0.877±0.087 |
| **As** | 25.5±1.7 | 18.8±1.2 | 13.50±0.89 | 13.96±0.89 | 13.4±1.4 | 14.57±0.96 | 13.43±0.87 |
| **Br** | 20.0±1.5 | 13.56±0.97 | 4.59±0.41 | 3.77±0.31 | 4.49±0.46 | 8.01±0.90 | 3.98±0.33 |
| **U** | 2.39±0.31 | 2.52±0.30 | 2.55±0.25 | 2.55±0.31 | 2.32±0.34 | 2.59±0.25 | 2.30±0.30 |
| **La** | 32.2 ±1.8 | 33.0±2.1 | 33.3±1.6 | 32.9±2.1 | 30.8±1.4 | 33.9±1.9 | 32.9±2.0 |
| **Ce** | 74.2±6.5 | 74.8±6.7 | 76.4±5.7 | 75.2±6.0 | 70.2±6.0 | 77.1±6.8 | 76.3±6.7 |
| **Nd** | 42.3±4.1 | 44.9±5.0 | 40.2±4.1 | 43.4±4.5 | 40.8±4.5 | 43.6±4.6 | 42.6±4.0 |
| **Sm** | 8.48±0.75 | 8.65±0.67 | 9.17±0.64 | 8.82±0.72 | 8.09±0.82 | 9.19±0.70 | 8.62±0.75 |
| **Eu** | 1.728±0.093 | 1.629±0.091 | 1.779±0.095 | 1.794±0.098 | 1.719±0.098 | 1.752±0.095 | 1.854±0.098 |
| **Tb** | 1.488±0.083 | 1.364±0.080 | 1.473±0.082 | 1.543±0.093 | 1.354±0.085 | 1.477±0.080 | 1.390±0.084 |
| **Dy** | 9.53±0.95 | 10.37±0.98 | 9.46±0.96 | 10.00±0.97 | 9.53±0.94 | 9.91±0.96 | 10.49±0.97 |
| **Yb** | 6.27±0.62 | 6.42±0.63 | 6.42±0.61 | 6.53±0.62 | 6.12±0.58 | 6.49±0.62 | 6.40±0.60 |
| **Lu** | 0.857±0.062 | 0.861±0.062 | 0.891±0.071 | 0.907±0.061 | 0.831±0.062 | 0.904±0.067 | 0.888±0.066 |

**trace elements** **as µg g-1.**

**Table S3. Continuing.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Layer** | MH4B | | MH5A | | MH5B | | MH5C |
| **Sample** | ST3pb18 | ST3o18 | ST5pb5 | ST5o5 | ST6pb18 | ST6o18 | ST7pb35 |
| **Type** | White pumice | Obsidians | White pumice | Obsidians | White pumice | Obsidians | White pumice |
| **SiO2** | 67.4 | 65.8 | 67.1 | 66.8 | 65.3 | 66.1 | 67.3 |
| **Al2O3** | 14.19 | 14.32 | 14.17 | 14.53 | 15.34 | 14.02 | 13.79 |
| **TiO2** | 0.72 | 0.80 | 0.82 | 0.83 | 0.66 | 0.76 | 0.81 |
| **Fe2O3 (Total)** | 4.87 | 5.12 | 4.87 | 4.92 | 4.81 | 5.12 | 5.51 |
| **MgO** | 1.15 | 1.31 | 1.20 | 1.36 | 1.39 | 1.35 | 1.32 |
| **CaO** | 2.74 | 3.27 | 2.71 | 1.83 | 3.74 | 3.32 | 2.38 |
| **Na2O** | 5.12 | 5.43 | 5.09 | 5.58 | 5.16 | 5.32 | 5.07 |
| **K2O** | 2.66 | 2.77 | 2.89 | 2.98 | 2.43 | 2.85 | 2.69 |
| **MnO** | 0.11 | 0.12 | 0.11 | 0.13 | 0.10 | 0.11 | 0.11 |
| **Sc** | 14.73±0.79 | 15.05±0.77 | 14.34±0.77 | 14.94±0.77 | 15.46±0.78 | 15.81±0.80 | 15.87±0.80 |
| **V** | 22.6±3.4 | 16.4±2.8 | 17.2±2.7 | 21.7±3.3 | 25.1±3.5 | 22.3±3.2 | 26.4±3.2 |
| **Cr** | 2.58±0.98 | 4.50±0.72 | 2.5±1.9 | 1.93±0.59 | 2.40±0.71 | 2.23±0.96 | 4.69±0.98 |
| **Co** | 4.68±0.23 | 4.79±0.23 | 4.46±0.22 | 4.93±0.24 | 4.28±020 | 5.06±0.24 | 5.11±0.94 |
| **Zn** | 96.1±6.9 | 99.0±6.7 | 97.0±6.9 | 98.0±6.7 | 84.8±5.7 | 99.7±7.0 | 98.8±6.8 |
| **Rb** | 77.0±6.5 | 76.0±4.5 | 74.9±7.1 | 69.7±3.8 | 62.5±3.7 | 73.9±4.8 | 76.2±5.1 |
| **Sr** | 223±47 | 209±42 | 222±52 | 199±38 | 320±65 | 226±53 | 156±40 |
| **Cs** | 4.31±0.27 | 4.50±0.31 | 4.44±0.28 | 4.20±0.26 | 3.85±0.26 | 4.72±0.29 | 4.66±0.29 |
| **Ba** | 747±62 | 729±61 | 728±62 | 697±59 | 663±57 | 774±66 | 740±61 |
| **Zr** | 390±85 | 364±58 | 332±71 | 3.22±47 | 311±58 | 372±67 | 393±90 |
| **Hf** | 9.54±0.49 | 9.31±0.47 | 9.52±0.49 | 8.82±0.45 | 8.18±0.41 | 9.43±0.48 | 9.44±0.47 |
| **Ta** | 0.545±0.041 | 0.568±0.047 | 0.554±0.044 | 0.540±0.044 | 0.501±0.036 | 0.553±0.043 | 0.564±0.038 |
| **Th** | 8.73±0.43 | 8.31±0.42 | 8.61±0.45 | 7.96±0.40 | 7.51±0.36 | 8.61±0.42 | 8.58±0.41 |
| **Sb** | 0.869±0.083 | 0.837±0.093 | 0.870±0.093 | 0.804±0.080 | 0.720±0.080 | 0.811±0.084 | 0.868±0.086 |
| **As** | 14.29±0.86 | 13.36±0.98 | 13.65±0.90 | 12.45±0.82 | 11.80±0.86 | 13.62±0.97 | 14.51±0.95 |
| **Br** | 14.18±0.97 | 3.93±0.50 | 8.41±0.72 | 3.61±0.31 | 11.22±0.89 | 4.08±0.36 | 11.21±0.85 |
| **U** | 2.55±0.35 | 2.11±0.23 | 2.32±0.22 | 12.12±0.22 | 2.01±0.30 | 2.36±0.23 | 2.36±0.29 |
| **La** | 33.1±1.6 | 32.7±1.9 | 32.7±1.7 | 31.6±1.6 | 28.4±1.6 | 33.8±1.8 | 32.4±1.7 |
| **Ce** | 75.2±6.4 | 73.3±6.6 | 74.2±6.5 | 70.6±5.5 | 66.1±4.9 | 75.6±6.7 | 77.0±6.5 |
| **Nd** | 44.8±5.2 | 42.7±4.0 | 41.2±3.8 | 39.2±4.0 | 36.6±3.4 | 45.6±5.0 | 43.2±4.5 |
| **Sm** | 9.05±0.72 | 8.72±0.82 | 8.67±0.68 | 8.58±0.71 | 7.68±0.67 | 9.02±0.75 | 8.84±0.72 |
| **Eu** | 1.845±0.098 | 1.877±0.098 | 1.723±0.096 | 1.749±0.094 | 1.861±0.096 | 1.924±0.098 | 1.810±0.097 |
| **Tb** | 1.451±0.090 | 1.462±0.085 | 1.399±0.090 | 1.361±0.075 | 1.271±0.073 | 1.451±0.085 | 1.496±0.086 |
| **Dy** | 9.71±0.98 | 10.23±0.98 | 9.40±0.89 | 9.69±0.98 | 8.98±0.98 | 10.02±0.98 | 9.95±0.96 |
| **Yb** | 6.25±0.59 | 6.26±0.59 | 6.41±0.60 | 6.08±0.58 | 5.56±0.52 | 6.39±0.63 | 6.41±0.62 |
| **Lu** | 0.888±0.059 | 0.854±0.064 | 0.849±0.061 | 0.845±0.063 | 0.763±0.054 | 0.890±0.065 | 0.865±0.061 |

**Table S3. Continuing.**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Layer** | MH5C | MH8 | | | | 1960CC | | | | | |
| **Sample** | ST7v35 | ST8pb | ST8pm18 | ST8e18 | ST8v18 | ST9o18 | | ST9pb18 | | ST9pm18 | |
| **Type** | Glass shards | White pumice | Brown pumice | Scoria | Glass shards | Obsidians | White pumice | | Brown pumice | |
| **SiO2** | 65.3 | 65.9 | 66.9 | 56.9 | 67.8 | 67.6 | 67.7 | | 55.9 | |
| **Al2O3** | 14.76 | 14.27 | 13.94 | 14.19 | 13.57 | 13.79 | 14.10 | | 14.98 | |
| **TiO2** | 0.85 | 0.85 | 0.76 | 1.52 | 0.71 | 0.70 | 0.62 | | 1.52 | |
| **Fe2O3 (Total)** | 5.05 | 5.37 | 5.28 | 10.34 | 5.28 | 5.31 | 4.32 | | 10.00 | |
| **MgO** | 1.27 | 1.55 | 1.37 | 3.25 | 1.35 | 1.32 | 1.11 | | 3.88 | |
| **CaO** | 3.05 | 2.85 | 2.63 | 6.79 | 2.21 | 2.11 | 2.64 | | 7.44 | |
| **Na2O** | 5.58 | 5.27 | 5.23 | 4.21 | 5.28 | 5.16 | 5.47 | | 3.75 | |
| **K2O** | 2.96 | 2.72 | 2.69 | 1.63 | 2.59 | 2.87 | 2.93 | | 1.34 | |
| **MnO** | 0.12 | 0.13 | 0.12 | 0.18 | 0.12 | 0.11 | 0.11 | | 0.16 | |
| **Sc** | 14.14±0.71 | 16.59±0.87 | 15.32±0,80 | 31.1±1.5 | 15.85±0.82 | 16.02±0.84 | 13.20±0.69 | | 33.6±1.7 | |
| **V** | 20.0±2.6 | 28.3±3.1 | 21.6±3.5 | 204.2±8.0 | 26.2±3.9 | 46.7±4.2 | 11.9±2.5 | | 278.3±9.2 | |
| **Cr** | 2.76±0.28 | 2.50±0.82 | 1.22±0.72 | 4.53±0.98 | 0.84±0.58 | 2.08±0.79 | 0.86±0.65 | | 30.4±2.2 | |
| **Co** | 4.59±0.22 | 5.75±0.26 | 5.09±0.25 | 19.40±0.89 | 5.43±0.26 | 5.91±0.28 | 3.79±0.18 | | 23.6±1.1 | |
| **Zn** | 110.0±7.5 | 100.1±6.8 | 104.3±7.7 | 128.1±8.9 | 105.1±7.4 | 97.2±6.6 | 92.9±6.3 | | 112.7±77 | |
| **Rb** | 79.5±4.5 | 68.0±3.7 | 76.2±5.3 | 46.1±4.6 | 66.7±4.4 | 74.0±4.1 | 72.4±4.1 | | 36.5±3.8 | |
| **Sr** | 196±46 | 245±58 | 216±59 | 411±52 | 268±64 | 263±54 | 243±54 | | 4.46±61 | |
| **Cs** | 4.70±0.28 | 4.22±0.25 | 4.56±0.30 | 2.96±0.20 | 4.33±0.26 | 4.57±0.30 | 4.64±0.31 | | 2.20±0.17 | |
| **Ba** | 764±61 | 683±58 | 738±64 | 462±48 | 702±62 | 742±65 | 755±62 | | 382±39 | |
| **Zr** | 388±79 | 319±48 | 373±100 | 251±67 | 331±68 | 358±64 | 343±49 | | 214±85 | |
| **Hf** | 9.64±0.48 | 8.48±0.45 | 9.25±0.48 | 5.90±0.30 | 8.78±0.45 | 9.37±0.48 | 9.56±0.48 | | 4.73±0.26 | |
| **Ta** | 0.576±0.042 | 0.520±0.034 | 0.527±0.075 | 0.372±0.031 | 0.503±0.051 | 0.522±0.056 | 0.554±0.036 | | 0.284±0.044 | |
| **Th** | 8.82±0.42 | 7.92±0.44 | 8.45±0.43 | 5.46±0.26 | 7.86±0.40 | 8.64±0.47 | 8.78±0.41 | | 4.11±0.21 | |
| **Sb** | 0.903±0.088 | 0.771±0.091 | 0.853±0.090 | 0.567±0.058 | 0.808±0.086 | 0.929±0.096 | 0.900±0.094 | | 0.500±0.067 | |
| **As** | 14.19±0.94 | 2.32±0.89 | 13.07±0.90 | 7.87±0.55 | 11.84±0.84 | 13.87±0.85 | 13.67±0.89 | | 6.30±0.69 | |
| **Br** | 4.14±0.32 | 4.83±0.55 | 4.54±0.39 | 2.09±0.22 | 3.27±0.35 | 4.00±0.34 | 4.00±0.35 | | 2.01±0.31 | |
| **U** | 2.50±0.36 | 2.24±0.28 | 2.15±0.23 | 1.56±0.14 | 2.18±0.21 | 2.52±0.31 | 2.59±0.30 | | 1.15±0.11 | |
| **La** | 33.8±2.1 | 32.2±1.7 | 32.3±2.0 | 24.2±1.2 | 32.2±1.6 | 32.7±1.6 | 33.1±1.6 | | 19.2±0.9 | |
| **Ce** | 77.0±6.6 | 79.1±5.1 | 74.2±5.7 | 57.2±4.1 | 71.7±6.0 | 73.4±6.4 | 74.7±6.4 | | 45.4±3.6 | |
| **Nd** | 43.0±4.0 | 39.3±3.5 | 42.5±4.0 | 34.3±4.2 | 39.7±3.8 | 41.1±±4.3 | 40.5±3.6 | | 27.1±3.0 | |
| **Sm** | 8.66±0.85 | 8.53±0.65 | 8.65±0.70 | 7.70±0.63 | 8.69±0.80 | 8.91±0.69 | 8.41±0.62 | | 6.29±0.51 | |
| **Eu** | 1.911±0.098 | 1.814±0.097 | 1.804±0.098 | 2.050±0.110 | 1.918±0.098 | 1.796±0.097 | 1.770±0.096 | | 1.690±0.096 | |
| **Tb** | 1.534±0.089 | 1.425±0.082 | 1.410±0.110 | 1.261±0.079 | 1.385±0.081 | 1.421±0.082 | 1.382±0.079 | | 0.987±0.066 | |
| **Dy** | 10.66±0.98 | 9.43±0.97 | 9.55±0.96 | 9.35±0.74 | 9.63±0.98 | 9.90±0.95 | 9.53±0.92 | | 6.34±0.62 | |
| **Yb** | 6.57±0.61 | 6.04±0.58 | 6.22±0.62 | 4.78±0.45 | 6.20±0.59 | 6.22±0.61 | 6.41±0.58 | | 3.77±0.36 | |
| **Lu** | 0.923±0.066 | 0.832±0.064 | 0.847±0.064 | 0.685±0.044 | 0.867±0.064 | 0.848±0.062 | 0.897±0.062 | | 0.538±0.039 | |

**Table S4. Volcanic glass EDS measurements (comparative quantification), oxides as wt%, nd: not detected.**

| **Layer** | MH4A | | | | MH5A | MH5C | | | MH8 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Type** | White pumice | White pumice | White pumice | White pumice | White pumice | White pumice | White pumice | White pumice | White pumice |
| **Sample** | Pb3\_3b.1 | Pb3\_2d.1 | Pb3\_2d.2 | Pb3\_1f.1 | Pb5\_1a.1 | Pb 7\_1a.1 | Pb7\_2e.1 | Pb7\_3d.1 | Pb8\_1a.1) |
| **SiO2** | 70.18 | 70.92 | 70.04 | 69.61 | 70.79 | 71.95 | 71.48 | 71.16 | 71.04 |
| **Al2O3** | 15.07 | 14.77 | 14.31 | 15.14 | 14.90 | 14.90 | 15.02 | 15.12 | 15.04 |
| **TiO2** | 0.81 | 0.79 | 0.69 | 0.84 | 0.50 | 0.55 | 0.69 | 0.77 | 0.65 |
| **Fe2O3 (Total)** | 4.46 | 4.41 | 4.98 | 4.54 | 4.13 | 4.28 | 4.25 | 4.34 | 4.15 |
| **MgO** | 0.77 | 0.60 | 0.59 | 0.83 | 0.55 | 0.46 | 0.51 | 0.56 | 0.61 |
| **CaO** | 2.40 | 2.11 | 3.22 | 2.48 | 2.02 | 2.10 | 2.24 | 2.33 | 2.23 |
| **Na2O** | 3.24 | 3.38 | 3.00 | 3.65 | 4.07 | 2.84 | 2.84 | 2.69 | 3.18 |
| **K2O** | 2.69 | 2.62 | 2.63 | 2.68 | 2.71 | 2.79 | 2.69 | 2.64 | 2.67 |
| **MnO** | 0.17 | 0.17 | 0.29 | 0.22 | 0.12 | 0.15 | 0.14 | 0.19 | 0.16 |
| **P2O5** | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| **Cl2O** | 0.22 | 0.23 | 0.25 | nd | 0.20 | nd | 0.14 | 0.20 | 0.26 |
| **Total** | 100.01 | 100.00 | 100.00 | 99.99 | 99.99 | 100.02 | 100.00 | 100.00 | 99.99 |
| **Layer** | 1960CC | | | MH8 | | 1960CC | | | |
| **Type** | White pumice | White pumice | White pumice | Brown pumice (BP1) | Brown pumice (BP2) | Brown pumice (BP2) | Brown pumice (BP1) | Brown pumice (BP2) | Brown pumice (BP2) |
| **Sample** | Pb9\_1c.1 | Pb9\_2C.1 | Pb9\_2d.1 | Pm8\_2b.1 | Pm8\_3c.1 | Pm9\_1b.1 | Pm9\_2 | Pm9\_3b.1 | Pm9\_4e.1 |
| **SiO2** | 71.70 | 66.54 | 68.89 | 55.90 | 58.63 | 61.46 | 69.34 | 69.35 | 68.54 |
| **Al2O3** | 15.07 | 18.12 | 15.39 | 15.39 | 15.27 | 14.36 | 15.40 | 16.29 | 15.17 |
| **TiO2** | 0.66 | 0.51 | 0.81 | 1.46 | 1.74 | 1.50 | 0.78 | 0.78 | 0.73 |
| **Fe2O3 (Total)** | 4.01 | 3.33 | 4.78 | 9.89 | 10.50 | 8.27 | 4.54 | 2.62 | 3.95 |
| **MgO** | 0.58 | 0.55 | 0.75 | 4.02 | 2.12 | 1.44 | 0.89 | 0.30 | 0.75 |
| **CaO** | 2.14 | 4.12 | 2.81 | 7.34 | 5.17 | 4.16 | 2.65 | 2.63 | 3.13 |
| **Na2O** | 2.98 | 4.96 | 2.94 | 4.32 | 4.97 | 4.88 | 3.53 | 4.74 | 5.88 |
| **K2O** | 2.71 | 1.69 | 2.48 | 1.41 | 1.23 | 2.41 | 2.70 | 3.21 | 1.65 |
| **MnO** | 0.16 | 0.18 | 0.16 | 0.26 | 0.37 | 0.23 | 0.17 | 0.09 | 0.20 |
| **P2O5** | nd | nd | nd | nd | nd | 1.29 | nd | nd | nd |
| **Cl2O** | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| **Total** | 100.01 | 100.00 | 99.01 | 99.99 | 100.00 | 100.00 | 100.00 | 100.01 | 100.00 |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Layer** | 1960CC | | | | | | | MH4B | | |
| **Type** | Brown pumice (BP2) | Brown pumice (BP2) | Brown pumice (BP2) | Brown pumice (BP2) | Brown pumice (BP2) | Brown pumice (BP2) | Brown pumice (BP2) | Scoria (Sa2) | Scoria (Sa2) | Scoria (Sa2) |
| **Sample** | Pm9\_4e.2 | Pm9\_4e.2 | Pm9\_4e.4 | Pm9\_4e.5 | Pm9\_4e.6 | Pm9\_5f.1 | Pm9\_5f.2 | E3\_1a.1 | E3\_1c.1 | E3\_1c.2 |
| **SiO2** | 68.83 | 69.80 | 68.92 | 68.30 | 72.61 | 61.45 | 61.49 | 73.86 | 72.36 | 72.01 |
| **Al2O3** | 15.50 | 15.24 | 15.17 | 15.19 | 14.72 | 14.72 | 15.79 | 14.36 | 13.48 | 15.78 |
| **TiO2** | 0.63 | 0.59 | 0.63 | 0.74 | 0.30 | 1.40 | 1.14 | 0.30 | 0.86 | 0.30 |
| **Fe2O3 (Total)** | 3.79 | 4.37 | 4.04 | 3.93 | 4.52 | 8.87 | 7.69 | 4.44 | 4.20 | 3.11 |
| **MgO** | 0.54 | 0.67 | 0.57 | 0.86 | 0.13 | 2.02 | 1.86 | 0.07 | 0.46 | 0.00 |
| **CaO** | 3.12 | 2.23 | 3.17 | 3.23 | 1.85 | 4.44 | 4.52 | 1.63 | 1.74 | 2.12 |
| **Na2O** | 5.92 | 3.65 | 5.75 | 6.03 | 3.00 | 5.28 | 5.66 | 2.37 | 3.31 | 4.49 |
| **K2O** | 1.55 | 3.33 | 1.58 | 1.60 | 2.85 | 1.51 | 1.60 | 2.92 | 3.22 | 2.17 |
| **MnO** | 0.13 | 0.13 | 0.18 | 0.12 | 0.03 | 0.31 | 0.24 | 0.05 | 0.16 | 0.03 |
| **P2O5** | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| **Cl2O** | nd | nd | nd | nd | nd | nd | nd | 0.01 | 0.22 | nd |
| **Total** | 100.01 | 100.01 | 100.01 | 100.00 | 100.01 | 100.00 | 99.99 | 100.01 | 100.01 | 100.01 |
| **Layer** | MH4B | | | | MH5A | | | | | |
| **Type** | Scoria (Sa1) | Scoria (Sa2) | Scoria (Sa2) | Scoria (Sa2) | Scoria (Sa1) | Scoria (Sa1) | Scoria (Sa1) | Scoria (Sa2) | Scoria (Sa2) | Scoria (Sa2) |
| **Sample** | E3\_2b.1 | E3\_3a.1 | E3\_4a.1 | E3\_4a.2 | E5\_1a.1 | E5\_1d.1 | E5\_2a.1 | E5\_3c.1 | E8\_2d.1 | E8\_3e.1 |
| **SiO2** | 68.25 | 68.98 | 71.24 | 71.07 | 68.18 | 71.27 | 69.56 | 70.50 | 62.50 | 57.79 |
| **Al2O3** | 15.13 | 15.69 | 14.85 | 15.12 | 15.42 | 15.08 | 14.88 | 15.03 | 21.99 | 15.98 |
| **TiO2** | 0.96 | 0.67 | 0.71 | 0.78 | 0.80 | 0.63 | 0.80 | 0.67 | 0.19 | 1.38 |
| **Fe2O3 (Total)** | 4.85 | 3.28 | 4.08 | 2.53 | 4.17 | 4.16 | 4.58 | 4.02 | 0.76 | 9.51 |
| **MgO** | 1.03 | 1.15 | 0.52 | 0.25 | 1.32 | 0.52 | 0.61 | 0.67 | 0.23 | 2.85 |
| **CaO** | 2.78 | 2.19 | 1.90 | 1.92 | 2.42 | 2.05 | 2.69 | 2.12 | 3.62 | 6.74 |
| **Na2O** | 3.69 | 4.87 | 3.01 | 5.37 | 4.54 | 3.51 | 3.65 | 3.62 | 7.54 | 4.34 |
| **K2O** | 2.79 | 2.68 | 3.31 | 2.55 | 2.72 | 2.47 | 2.75 | 2.96 | 3.08 | 1.19 |
| **MnO** | 0.23 | 0.21 | 0.18 | 0.13 | 0.16 | 0.22 | 0.26 | 0.18 | 0.09 | 0.21 |
| **P2O5** | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| **Cl2O** | 0.29 | 0.28 | 0.21 | 0.28 | 0.27 | 0.09 | 0.21 | 0.23 | nd | nd |
| **Total** | 100.00 | 100.00 | 100.01 | 100.00 | 100.00 | 100.00 | 99.99 | 100.00 | 100.00 | 99.99 |

**Table S4. Continuing.**

**Table S4. Continuing.**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Layer** | MH5A | 1960CC | MH1.2 B | | | MH8 | | | MH3 |
| **Type** | Scoria (Sa2) | Scoria (Sa1) | Glass shardGS1 | Glass shardGS1 | Glass shard (GS1) | Glass shard (GS2) | Glass shard (GS2) | Glass shard (GS2) | Obsidian (Ob1) |
| **Sample** | E8\_4h.1 | E9\_1c.1 | V1\_2.1 | V1\_3.1 | V1\_4.1 | V8\_2e.1 | V8\_3a.1 | V8\_1f.1 | O1\_2.1 |
| **SiO2** | 55.88 | 69.72 | 70.76 | 71.13 | 72.49 | 68.32 | 68.09 | 69.52 | 69.89 |
| **Al2O3** | 26.36 | 15.07 | 15.00 | 15.01 | 14.79 | 15.62 | 15.53 | 15.42 | 14.99 |
| **TiO2** | 0.20 | 0.69 | 0.69 | 0.70 | 0.49 | 0.91 | 0.90 | 0.91 | 0.58 |
| **Fe2O3 (Total)** | 1.21 | 3.97 | 3.97 | 4.08 | 4.40 | 5.00 | 5.21 | 4.56 | 4.04 |
| **MgO** | 0.04 | 0.65 | 0.69 | 0.60 | 0.10 | 1.13 | 1.09 | 0.89 | 0.63 |
| **CaO** | 9.61 | 2.00 | 2.15 | 2.14 | 1.99 | 3.04 | 3.03 | 2.67 | 2.05 |
| **Na2O** | 5.94 | 4.62 | 3.53 | 3.38 | 3.11 | 3.23 | 3.40 | 3.25 | 4.75 |
| **K2O** | 0.62 | 2.86 | 2.76 | 2.59 | 2.47 | 2.62 | 2.53 | 2.59 | 2.78 |
| **MnO** | 0.13 | 0.15 | 0.18 | 0.15 | 0.15 | 0.14 | 0.22 | 0.19 | 0.15 |
| **P2O5** | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| **Cl2O** | nd | 0.27 | 0.28 | 0.22 | nd | nd | nd | nd | 0.15 |
| **Total** | 99.99 | 100.00 | 100.01 | 100.00 | 99.99 | 100.01 | 100.00 | 100.00 | 100.01 |
| **Layer** | MH3 | | MH5A | MH5B | | | | | |
| **Type** | Obsidian (Ob1) | Obsidian (Ob1) | Obsidian (Ob1) | Obsidian (Ob2) | Obsidian (Ob1) | Obsidian (Ob2) | Obsidian (Ob2) | Obsidian (Ob2) | Obsidian (Ob2) |
| **Sample** | O1\_3.1 | O2\_2.1 | O6\_1.1 | O6\_2h.1 | O6\_3a.1 | O6\_4g.1 | O6\_4g.2 | O6\_4g.3 | O6\_4g.a1 |
| **SiO2** | 69.98 | 72.43 | 69.41 | 70.32 | 70.41 | 71.78 | 68.64 | 72.83 | 68.74 |
| **Al2O3** | 14.9 | 14.51 | 15.05 | 15.03 | 15.11 | 15.06 | 15.22 | 15.25 | 14.66 |
| **TiO2** | 0.65 | 0.46 | 0.77 | 0.78 | 0.77 | 0.71 | 0.82 | 0.67 | 0.78 |
| **Fe2O3 (Total)** | 4.07 | 4.46 | 4.51 | 4.34 | 4.36 | 3.63 | 5.34 | 3.16 | 3.51 |
| **MgO** | 0.57 | 0.09 | 0.82 | 0.71 | 0.70 | 0.57 | 0.92 | 0.16 | 0.76 |
| **CaO** | 2.07 | 1.94 | 2.4 | 2.35 | 2.36 | 1.99 | 2.82 | 2.03 | 2.08 |
| **Na2O** | 4.67 | 3.14 | 3.81 | 3.29 | 3.18 | 3.17 | 3.32 | 2.98 | 6.08 |
| **K2O** | 2.74 | 2.7 | 2.79 | 2.7 | 2.75 | 2.67 | 2.5 | 2.66 | 2.87 |
| **MnO** | 0.19 | 0.27 | 0.21 | 0.17 | 0.19 | 0.16 | 0.26 | 0.14 | 0.22 |
| **P2O5** | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| **Cl2O** | 0.15 | nd | 0.22 | 0.3 | 0.17 | 0.28 | 0.17 | 0.12 | 0.28 |
| **Total** | 99.99 | 100 | 99.99 | 99.99 | 100.00 | 100.02 | 100.01 | 100 | 99.98 |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Layer** | CC1960 | | | | | MH5C | | | |
| **Type** | Obsidian (Ob2) | Obsidian (Ob2) | Obsidian (Ob2) | Obsidian (Ob2) | Obsidian (Ob2) | Crystaloclast | Crystaloclast | Crystaloclast | Crystaloclast |
| **Sample** | O9\_1a.1 | 09\_1e.1 | 09\_1e.1 | 09\_1e.2 | 09\_2c.1 | C7\_1.1 | C7\_1.2 | C7\_2.1 | C7\_2.2 |
| **SiO2** | 70.82 | 70.97 | 71.35 | 69.76 | 70.25 | 71.08 | 71.31 | 69.16 | 70.79 |
| **Al2O3** | 15.12 | 15.31 | 15.11 | 15.23 | 15.02 | 14.68 | 14.67 | 15.01 | 14.39 |
| **TiO2** | 0.75 | 0.77 | 0.69 | 0.78 | 0.59 | 0.8 | 0.7 | 0.79 | 0.63 |
| **Fe2O3 (Total)** | 4.31 | 3.41 | 3.56 | 4.31 | 3.92 | 4.14 | 3.96 | 4.05 | 4.07 |
| **MgO** | 0.66 | 0.45 | 0.46 | 0.62 | 0.66 | 0.54 | 0.61 | 0.65 | 0.55 |
| **CaO** | 2.22 | 1.91 | 1.84 | 2.09 | 2.06 | 2.01 | 2.04 | 2.22 | 2.07 |
| **Na2O** | 3.06 | 3.71 | 3.64 | 3.87 | 4.34 | 3.56 | 3.45 | 4.68 | 4.21 |
| **K2O** | 2.65 | 2.99 | 3.02 | 2.87 | 2.75 | 2.76 | 2.82 | 2.88 | 2.84 |
| **MnO** | 0.23 | 0.21 | 0.12 | 0.23 | 0.18 | 0.21 | 0.2 | 0.28 | 0.22 |
| **P2O5** | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| **Cl2O** | 0.17 | 0.25 | 0.20 | 0.26 | 0.23 | 0.23 | 0.24 | 0.29 | 0.22 |
| **Total** | 99.99 | 99.98 | 99.99 | 100.02 | 100.00 | 100.01 | 100 | 100.01 | 99.99 |

**Table S4. Continuing.**