

# Supplementary Materials: Origin and Evolution of Ore-Bearing Rocks in the Loypishnun Deposit (Monchetundra Massif, NE Fennoscandian Shield): Isotope Nd-Sr and REE Geochemical Data

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**Table S1.** Main oxides composition of Loypishnun area rocks.

| Rock                           | Amp-Gabbronorites |        |        |         |        |        |         | Gabbro-Pegmatites |             | Pyroxenites |        |        |         | Harzburgite | Dunites         |        |        |        |
|--------------------------------|-------------------|--------|--------|---------|--------|--------|---------|-------------------|-------------|-------------|--------|--------|---------|-------------|-----------------|--------|--------|--------|
| Oxides                         | 70/9              | 70/21  | 70/41  | 70/63   | 70/81  | 70/94  | 70/157  | 70/264            | 70/275      | 70/127      | 70/165 | 70/172 | 70/204  | 70/200      | 70/129          | 70/137 | 70/219 | 70/324 |
| SiO <sub>2</sub>               | 49.07             | 50.67  | 48.37  | 50.72   | 50.88  | 50.86  | 50.6    | 52.14             | 55.54       | 51.22       | 49.39  | 52.51  | 53.76   | 45.91       | 37.16           | 35.96  | 39.7   | 38.72  |
| TiO <sub>2</sub>               | 0.36              | 0.22   | 0.41   | 0.25    | 0.22   | 0.25   | 0.28    | 0.47              | 1.12        | 0.31        | 0.68   | 0.2    | 0.15    | 0.11        | 0.032           | 0.075  | 0.04   | 0.04   |
| Al <sub>2</sub> O <sub>3</sub> | 12.01             | 15.87  | 8.95   | 13.77   | 19.52  | 11.13  | 14.23   | 10.63             | 17.03       | 5.36        | 3.73   | 5.15   | 4.27    | 3.6         | 1.01            | 1.45   | 1.17   | 1.81   |
| FeO                            | 11.2              | 6.12   | 13.85  | 6.98    | 4.63   | 8.79   | 6.73    | 15.82             | 10.43       | 16.65       | 21.6   | 9.09   | 9.08    | 10.33       | 6.02            | 4.74   | 8.51   | 6.31   |
| Fe <sub>2</sub> O <sub>3</sub> | 2.19              | 1.13   | 2.79   | 1.07    | 1.09   | 1.04   | 0.86    | -                 | -           | 0.98        | 0.69   | -      | -       | 0.47        | 2.77            | 3.48   | 1.06   | 2.1    |
| MnO                            | 0.25              | 0.17   | 0.31   | 0.18    | 0.11   | 0.22   | 0.18    | 0.27              | 0.13        | 0.39        | 0.36   | 0.19   | 0.2     | 0.2         | 0.16            | 0.14   | 0.15   | 0.14   |
| MgO                            | 9.47              | 8.7    | 11.8   | 9.64    | 5.4    | 10.52  | 9.57    | 9.91              | 5.33        | 16.37       | 15.68  | 25.42  | 27.95   | 34.46       | 45.99           | 42.76  | 46.38  | 43.11  |
| CaO                            | 10.46             | 13.02  | 8.17   | 12.45   | 12.68  | 12.54  | 12.95   | 5.46              | 5.09        | 5.62        | 3.98   | 3.99   | 3       | 2.02        | 0.23            | 0.87   | 0.68   | 0.69   |
| Na <sub>2</sub> O              | 1.43              | 2.18   | 1.38   | 2.32    | 2.98   | 1.24   | 2.09    | 1.2               | 2.39        | 0.84        | 0.31   | 0.37   | 0.37    | 0.3         | 0.057           | 0.074  | 0.061  | 0.086  |
| K <sub>2</sub> O               | 0.24              | 0.1    | 0.15   | 0.33    | 0.17   | 0.17   | 0.43    | 0.31              | 1           | 0.19        | 0.22   | 0.18   | 0.1     | 0.062       | 0.018           | 0.081  | 0.018  | 0.016  |
| P <sub>2</sub> O <sub>5</sub>  | 0.05              | 0.02   | 0.04   | 0.02    | 0.03   | 0.03   | 0.03    | 0.06              | 0.03        | 0.03        | 0.03   | 0.02   | 0.02    | 0.03        | 0.02            | 0.03   | 0.03   | 0.04   |
| CO <sub>2</sub>                | 0.1               | 0.12   | 0.1    | 0.17    | 0.1    | 0.61   | 0.26    | 0.14              | 0.1         | 0.13        | 0.1    | 0.54   | 0.13    | 0.24        | 0.7             | 1.36   | 0.37   | 0.95   |
| F                              | 0.006             | 0.004  | 0.008  | 0.004   | 0.004  | 0.006  | 0.004   | 0.008             | 0.019       | 0.007       | 0.008  | 0.007  | 0.006   | 0.006       | 0.021           | 0.026  | 0.005  | 0.005  |
| S                              | 0.02              | 0.06   | 0.02   | 0.02    | 0.08   | 0.07   | 0.04    | 0.29              | 0.32        | 0.03        | 0.57   | 0.03   | 0.05    | 0.04        | 0.01            | 0.02   | 0.03   | 0.03   |
| H <sub>2</sub> O <sup>+</sup>  | 2.6               | 1.6    | 2.83   | 2.1     | 1.77   | 1.97   | 2.08    | 1.79              | 1.44        | 2.06        | 2.05   | 2.13   | 1.07    | 1.66        | 5.36            | 8.16   | 1.51   | 5.6    |
| H <sub>2</sub> O <sup>-</sup>  | 0.07              | 0.07   | 0.13   | 0.09    | 0.1    | 0.09   | 0.1     | 0.16              | 0.13        | 0.07        | 0.02   | 0.1    | 0.06    | 0.12        | 0.32            | 0.36   | 0.13   | 0.32   |
| Total oxides                   | 99.53             | 100.05 | 99.308 | 100.114 | 99.76  | 99.54  | 100.434 | 98.658            | 100.099     | 100.257     | 99.418 | 99.927 | 100.216 | 99.558      | 99.878          | 99.586 | 99.844 | 99.967 |
| Rock                           | Norites           |        |        |         |        |        |         |                   | Ore-Norites |             |        |        |         |             | Ore-Pyroxenites |        |        |        |
| Oxides                         | 70/127.6          | 70/104 | 70/151 | 70/170  | 70/196 | 70/214 | 70/303  | 70/177            | 70/245      | 70/259      | 70/281 | 70/319 | 70/189  | 70/194      | 70/225          |        |        |        |
| SiO <sub>2</sub>               | 52.04             | 47.73  | 48.82  | 53.98   | 51.44  | 52.97  | 52.54   | 51.48             | 49.85       | 50.48       | 51.17  | 52.24  | 51.36   | 51.72       | 51.6            |        |        |        |

|                                    |         |        |        |        |         |         |        |        |        |         |        |        |        |        |        |
|------------------------------------|---------|--------|--------|--------|---------|---------|--------|--------|--------|---------|--------|--------|--------|--------|--------|
| <b>TiO<sub>2</sub></b>             | 0.41    | 0.83   | 1.42   | 0.46   | 0.18    | 0.16    | 0.14   | 0.26   | 0.32   | 0.42    | 0.38   | 0.33   | 0.21   | 0.22   | 0.21   |
| <b>Al<sub>2</sub>O<sub>3</sub></b> | 1.77    | 3.23   | 7.74   | 6.32   | 9.04    | 6.96    | 12.33  | 13.01  | 6.15   | 9.56    | 11.7   | 9.08   | 4.75   | 11.81  | 10.08  |
| <b>FeO</b>                         | 19.5    | 20.84  | 19.1   | 17.23  | 10.46   | 9.88    | 7.4    | 9.22   | 17.33  | 15.89   | 12.98  | 10.3   | 11.71  | 8.62   | 11.77  |
| <b>Fe<sub>2</sub>O<sub>3</sub></b> | 1.73    | 1.37   | 0.47   | 0.51   | 1.3     | 0       | 0.38   | 1.37   | 0.23   | 0.43    | 0.21   | 0.85   | 2.24   | 0.22   | 0.16   |
| <b>MnO</b>                         | 0.48    | 0.4    | 0.33   | 0.29   | 0.23    | 0.21    | 0.18   | 0.16   | 0.31   | 0.28    | 0.24   | 0.2    | 0.27   | 0.17   | 0.24   |
| <b>MgO</b>                         | 16.79   | 15.19  | 9.72   | 14.38  | 17.4    | 22.62   | 13.61  | 12.21  | 15.2   | 11.27   | 11.01  | 15.97  | 20.26  | 17.18  | 13.59  |
| <b>CaO</b>                         | 4.51    | 5.4    | 6.99   | 2.17   | 6.49    | 5.37    | 10.07  | 7.88   | 5.1    | 7.94    | 7.58   | 5.81   | 5.16   | 6.15   | 7.03   |
| <b>Na<sub>2</sub>O</b>             | 0.49    | 0.45   | 1.22   | 0.96   | 0.95    | 0.57    | 1.11   | 1.38   | 0.73   | 1.42    | 1.39   | 0.82   | 0.41   | 1.08   | 1.22   |
| <b>K<sub>2</sub>O</b>              | 0.07    | 0.078  | 0.24   | 0.59   | 0.18    | 0.14    | 0.07   | 0.64   | 0.29   | 0.27    | 0.18   | 0.19   | 0.19   | 0.37   | 0.22   |
| <b>P<sub>2</sub>O<sub>5</sub></b>  | 0.05    | 0.05   | 0.05   | 0.04   | 0.04    | 0.03    | 0.04   | 0.05   | 0.03   | 0.03    | 0.06   | 0.02   | 0.04   | 0.02   | 0.03   |
| <b>CO<sub>2</sub></b>              | 0.1     | 1.95   | 0.14   | 0.12   | 0.34    | 0.13    | 0.1    | 0.13   | 0.1    | 0.1     | 0.24   | 0.37   | 0.16   | 0.29   | 0.1    |
| <b>F</b>                           | 0.014   | 0.007  | 0.016  | 0.017  | 0.004   | 0.006   | 0.004  | 0.01   | 0.006  | 0.006   | 0.007  | 0.007  | 0.006  | 0.007  | 0.004  |
| <b>S</b>                           | 0.09    | 0.17   | 0.65   | 0.33   | 0.02    | 0.04    | 0.03   | 0.44   | 0.5    | 0.29    | 0.28   | 0.41   | 0.24   | 0.16   | 0.34   |
| <b>H<sub>2</sub>O<sup>+</sup></b>  | 2.24    | 1.92   | 1.76   | 1.63   | 2.01    | 1.23    | 1.1    | 1.86   | 2.45   | 1.73    | 1.93   | 1.96   | 2.65   | 1.63   | 1.75   |
| <b>H<sub>2</sub>O<sup>-</sup></b>  | 0.06    | 0.1    | 0.11   | 0.05   | 0.11    | 0.06    | 0.1    | 0.07   | 0.07   | 0.07    | 0.16   | 0.1    | 0.17   | 0.05   | 0.06   |
| <b>Total oxides</b>                | 100.344 | 99.715 | 98.776 | 99.077 | 100.194 | 100.376 | 99.204 | 100.17 | 98.666 | 100.186 | 99.517 | 98.657 | 99.826 | 99.697 | 98.404 |

Table S2. Trace and rare earth elements of Loypishnun area rocks.

| Rock      | Amp-Gabbro-norites |        |       |        |        |       |        | Gabbro-Pegmatites |        | Pyroxenites |        |        |        | Harzburgite | Dunites |        |        |        |
|-----------|--------------------|--------|-------|--------|--------|-------|--------|-------------------|--------|-------------|--------|--------|--------|-------------|---------|--------|--------|--------|
| Element   | 70/9               | 70/21  | 70/40 | 70/62  | 70/81  | 70/93 | 70/157 | 70/264            | 70/275 | 70/127      | 70/165 | 70/172 | 70/204 | 70/200      | 70/129  | 70/137 | 70/219 | 70/324 |
| <b>Ba</b> | 22.69              | 48.91  | 11.09 | 69.47  | 112.52 | 25.31 | 104.83 | 89.47             | 256.78 | 60          | 38.06  | 29.05  | 16.08  | 13.95       | 3.40    | 24.06  | 2.62   | 1.55   |
| <b>Rb</b> | 1.95               | 1.06   | 1.27  | 6.55   | 4.11   | 2.01  | 7.64   | 10.86             | 40.72  | 5.5         | 8.46   | 5.25   | 2.40   | 1.95        | 1.51    | 4.53   | 1.10   | 0.86   |
| <b>Sr</b> | 26.81              | 250.30 | 33.27 | 217.06 | 344.21 | 92.13 | 251.99 | 147.71            | 381.38 | 21          | 21.55  | 36.09  | 38.52  | 33.35       | 4.80    | 8.44   | 4.69   | 4.53   |
| <b>Zr</b> | 18.02              | 5.14   | 19.87 | 9.60   | 8.00   | 6.43  | 8.93   | 29.25             | 66.25  | 13.8        | 27.42  | 7.59   | 4.38   | 4.10        | 0.74    | 6.92   | 1.56   | 1.01   |
| <b>Nb</b> | 2.93               | <0.08  | 0.66  | 0.31   | 0.31   | 0.35  | 0.31   | 1.50              | 5.36   | 0.50        | 1.20   | 0.35   | 0.15   | 0.12        | 0.35    | 3.51   | 0.23   | 0.12   |
| <b>La</b> | 2.80               | 0.98   | 2.78  | 1.79   | 1.74   | 1.10  | 1.64   | 7.02              | 16.84  | 1.58        | 3.14   | 0.93   | 0.90   | 0.60        | 0.09    | 0.28   | 0.20   | 0.11   |
| <b>Ce</b> | 5.92               | 2.39   | 5.84  | 3.82   | 3.46   | 2.89  | 4.05   | 13.94             | 31.48  | 3.6         | 6.29   | 2.00   | 1.42   | 1.27        | 0.18    | 0.56   | 0.52   | 0.22   |
| <b>Pr</b> | 0.87               | 0.38   | 0.76  | 0.60   | 0.53   | 0.46  | 0.57   | 1.76              | 3.45   | 0.46        | 0.73   | 0.27   | 0.17   | 0.16        | 0.03    | 0.09   | 0.08   | 0.04   |
| <b>Nd</b> | 3.19               | 1.70   | 3.31  | 2.78   | 2.11   | 2.28  | 2.73   | 6.89              | 12.17  | 2.3         | 3.00   | 1.10   | 0.70   | 0.63        | 0.14    | 0.44   | 0.34   | 0.18   |
| <b>Sm</b> | 0.81               | 0.55   | 0.86  | 0.84   | 0.55   | 0.65  | 0.78   | 1.53              | 2.00   | 0.56        | 0.70   | 0.34   | 0.21   | 0.18        | 0.05    | 0.15   | 0.07   | 0.05   |
| <b>Eu</b> | 0.42               | 0.28   | 0.39  | 0.38   | 0.37   | 0.32  | 0.37   | 0.47              | 1.48   | 0.22        | 0.22   | 0.09   | 0.06   | 0.08        | <0.005  | 0.01   | 0.01   | 0.01   |
| <b>Gd</b> | 1.05               | 0.80   | 0.93  | 0.99   | 0.72   | 0.91  | 0.92   | 1.27              | 2.01   | 0.79        | 1.00   | 0.34   | 0.24   | 0.23        | 0.04    | 0.12   | 0.09   | 0.07   |

|                      |          |        |        |        |        |        |        |            |        |             |        |        |        |        |                 |      |       |       |
|----------------------|----------|--------|--------|--------|--------|--------|--------|------------|--------|-------------|--------|--------|--------|--------|-----------------|------|-------|-------|
| Tb                   | 0.19     | 0.14   | 0.17   | 0.18   | 0.12   | 0.16   | 0.17   | 0.22       | 0.29   | 0.14        | 0.19   | 0.07   | 0.04   | 0.04   | 0.01            | 0.02 | 0.01  | 0.01  |
| Dy                   | 1.32     | 0.90   | 1.20   | 1.19   | 0.73   | 1.20   | 1.15   | 1.46       | 1.43   | 1.17        | 1.32   | 0.47   | 0.36   | 0.27   | 0.05            | 0.13 | 0.09  | 0.07  |
| Ho                   | 0.28     | 0.19   | 0.30   | 0.26   | 0.16   | 0.27   | 0.24   | 0.36       | 0.33   | 0.30        | 0.32   | 0.12   | 0.09   | 0.06   | 0.01            | 0.03 | 0.02  | 0.02  |
| Er                   | 0.81     | 0.56   | 0.95   | 0.74   | 0.43   | 0.80   | 0.65   | 1.04       | 0.92   | 0.83        | 1.01   | 0.38   | 0.28   | 0.18   | 0.03            | 0.07 | 0.05  | 0.06  |
| Tm                   | 0.13     | 0.09   | 0.15   | 0.11   | 0.06   | 0.12   | 0.10   | 0.15       | 0.17   | 0.14        | 0.17   | 0.06   | 0.05   | 0.03   | 0.01            | 0.01 | 0.01  | 0.01  |
| Yb                   | 0.90     | 0.58   | 0.96   | 0.73   | 0.41   | 0.80   | 0.62   | 1.05       | 1.16   | 0.90        | 1.25   | 0.38   | 0.32   | 0.20   | 0.04            | 0.06 | 0.10  | 0.09  |
| Lu                   | 0.14     | 0.09   | 0.15   | 0.11   | 0.06   | 0.12   | 0.10   | 0.15       | 0.16   | 0.14        | 0.21   | 0.06   | 0.05   | 0.03   | 0.01            | 0.01 | 0.02  | 0.02  |
| Y                    | 8.60     | 5.81   | 8.19   | 7.81   | 4.74   | 8.19   | 7.12   | 9.81       | 9.39   | 8.5         | 10.76  | 3.90   | 2.86   | 1.72   | 1.01            | 0.65 | 0.55  | 0.71  |
| Cs                   | <0.1     | <0.1   | 0.15   | 0.11   | 0.15   | <0.1   | 0.15   | 0.30       | 1.27   | 0.11        | 0.22   | 0.26   | 0.11   | <0.1   | <0.1            | <0.1 | <0.1  | <0.1  |
| Ta                   | 0.46     | <0.05  | 0.06   | 0.09   | <0.05  | 0.09   | <0.05  | 0.11       | 0.34   | <0.05       | 0.06   | <0.05  | <0.05  | <0.05  | 0.06            | 0.09 | <0.05 | <0.05 |
| Hf                   | 0.46     | 0.19   | 0.46   | 0.22   | 0.24   | 0.24   | 0.28   | 0.66       | 1.61   | 0.35        | 0.69   | 0.23   | 0.13   | 0.17   | <0.05           | 0.14 | 0.06  | <0.05 |
| Th                   | 0.29     | 0.03   | 0.35   | 0.16   | 0.10   | 0.03   | 0.10   | 1.84       | 3.46   | 0.25        | 0.57   | 0.13   | 0.10   | 0.06   | 0.06            | 0.10 | 0.06  | 0.03  |
| U                    | 0.09     | 0.02   | 0.09   | 0.07   | 0.03   | 0.02   | 0.03   | 0.33       | 0.80   | 0.054       | 0.11   | 0.03   | <0.02  | 0.02   | 0.03            | 0.04 | <0.02 | <0.02 |
| Total REE            | 18.83    | 9.63   | 18.74  | 14.52  | 11.46  | 12.08  | 14.09  | 37.32      | 73.88  | 13.08       | 19.55  | 6.62   | 4.89   | 3.96   | 0.67            | 1.97 | 1.62  | 0.95  |
| LREE                 | 15.06    | 7.08   | 14.86  | 11.20  | 9.48   | 8.62   | 11.07  | 32.89      | 4.43   | 9.47        | 15.08  | 5.08   | 3.70   | 3.15   | 0.44            | 1.37 | 1.11  | 0.57  |
| HREE                 | 3.77     | 2.55   | 3.88   | 3.32   | 1.98   | 3.47   | 3.02   | 69.42      | 4.46   | 3.62        | 4.47   | 1.54   | 1.19   | 0.81   | 0.14            | 0.32 | 0.31  | 0.28  |
| Eu/Eu*               | 1.39     | 1.30   | 1.32   | 1.26   | 1.78   | 1.27   | 1.34   | 1.03       | 2.25   | 1.00        | 0.80   | 0.84   | 0.85   | 1.20   | 0.36            | 0.34 | 0.41  | 0.80  |
| (La/Yb) <sub>n</sub> | 2.10     | 1.14   | 1.95   | 1.66   | 2.86   | 0.93   | 1.79   | 4.52       | 9.77   | 1.18        | 1.69   | 1.65   | 1.89   | 2.05   | 1.73            | 3.11 | 1.32  | 0.81  |
| Rock                 | Norites  |        |        |        |        |        |        |            |        | Ore-Norites |        |        |        |        | Ore-Pyroxenites |      |       |       |
| Element              | 70/127.6 | 70/104 | 70/151 | 70/170 | 70/196 | 70/214 | 70/303 | 70/17<br>7 | 70/245 | 70/25<br>9  | 70/281 | 70/319 | 70/189 | 70/194 | 70/225          |      |       |       |
| Ba                   | 12.0     | 5.2    | 57     | 132.71 | 48.27  | 32.97  | 32.30  | 206.89     | 74.76  | 83.94       | 60.15  | 57.79  | 40.22  | 132.72 | 60.45           |      |       |       |
| Rb                   | 1.06     | 0.51   | 4.1    | 23.68  | 4.52   | 4.04   | 1.99   | 22.30      | 9.39   | 7.39        | 3.67   | 4.99   | 6.14   | 8.55   | 4.42            |      |       |       |
| Sr                   | 23       | 34     | 129    | 86.62  | 115.73 | 85.97  | 164.51 | 186.10     | 72.73  | 153.58      | 159.23 | 117.66 | 46.21  | 155.44 | 137.47          |      |       |       |
| Zr                   | 21       | 23     | 41     | 52.32  | 7.50   | 5.72   | 4.62   | 22.38      | 16.44  | 17.60       | 16.11  | 39.01  | 6.84   | 11.23  | 7.81            |      |       |       |
| Nb                   | 0.89     | 0.85   | 2.5    | 2.77   | 0.50   | 0.15   | 0.23   | 1.08       | 0.66   | 0.81        | 0.77   | 1.85   | 0.35   | 0.54   | 0.27            |      |       |       |
| La                   | 0.66     | 2.7    | 7.2    | 9.56   | 1.13   | 0.87   | 0.96   | 5.20       | 3.20   | 3.37        | 3.68   | 4.65   | 1.02   | 2.21   | 1.43            |      |       |       |
| Ce                   | 2.5      | 5.5    | 15.5   | 19.22  | 2.33   | 1.80   | 2.12   | 10.31      | 6.54   | 7.31        | 7.60   | 10.01  | 2.09   | 4.44   | 2.81            |      |       |       |
| Pr                   | 0.46     | 0.68   | 2.0    | 2.30   | 0.27   | 0.24   | 0.27   | 1.33       | 0.79   | 0.95        | 0.99   | 1.16   | 0.27   | 0.52   | 0.35            |      |       |       |
| Nd                   | 2.4      | 3.2    | 7.9    | 8.07   | 1.04   | 1.05   | 1.04   | 4.48       | 3.19   | 3.96        | 4.20   | 4.79   | 1.06   | 2.06   | 1.37            |      |       |       |
| Sm                   | 0.84     | 0.90   | 1.78   | 1.46   | 0.32   | 0.34   | 0.34   | 0.97       | 0.72   | 1.00        | 1.00   | 0.93   | 0.30   | 0.41   | 0.34            |      |       |       |
| Eu                   | 0.26     | 0.22   | 0.44   | 0.40   | 0.12   | 0.11   | 0.19   | 0.36       | 0.28   | 0.37        | 0.38   | 0.20   | 0.12   | 0.14   | 0.18            |      |       |       |

|                            |       |       |       |       |       |       |      |       |       |       |       |       |       |       |       |
|----------------------------|-------|-------|-------|-------|-------|-------|------|-------|-------|-------|-------|-------|-------|-------|-------|
| <b>Gd</b>                  | 1.02  | 1.12  | 1.94  | 1.62  | 0.36  | 0.30  | 0.46 | 0.89  | 0.97  | 1.30  | 0.99  | 0.90  | 0.37  | 0.48  | 0.38  |
| <b>Tb</b>                  | 0.20  | 0.24  | 0.33  | 0.25  | 0.05  | 0.06  | 0.08 | 0.14  | 0.17  | 0.19  | 0.19  | 0.16  | 0.06  | 0.08  | 0.06  |
| <b>Dy</b>                  | 1.41  | 1.49  | 2.2   | 1.63  | 0.37  | 0.41  | 0.46 | 0.89  | 1.12  | 1.38  | 1.21  | 1.13  | 0.46  | 0.46  | 0.49  |
| <b>Ho</b>                  | 0.33  | 0.33  | 0.48  | 0.36  | 0.09  | 0.10  | 0.10 | 0.21  | 0.25  | 0.30  | 0.25  | 0.24  | 0.12  | 0.09  | 0.12  |
| <b>Er</b>                  | 1.04  | 1.06  | 1.45  | 1.12  | 0.30  | 0.33  | 0.30 | 0.59  | 0.74  | 0.95  | 0.80  | 0.75  | 0.38  | 0.30  | 0.35  |
| <b>Tm</b>                  | 0.16  | 0.17  | 0.22  | 0.18  | 0.05  | 0.05  | 0.05 | 0.09  | 0.11  | 0.14  | 0.12  | 0.12  | 0.06  | 0.05  | 0.06  |
| <b>Yb</b>                  | 1.08  | 1.13  | 1.47  | 1.16  | 0.35  | 0.35  | 0.32 | 0.60  | 0.75  | 0.99  | 0.80  | 0.75  | 0.44  | 0.32  | 0.40  |
| <b>Lu</b>                  | 0.16  | 0.17  | 0.22  | 0.18  | 0.06  | 0.06  | 0.05 | 0.09  | 0.11  | 0.15  | 0.12  | 0.12  | 0.07  | 0.05  | 0.06  |
| <b>Y</b>                   | 9.8   | 10.2  | 14.2  | 10.40 | 3.44  | 3.48  | 3.02 | 6.11  | 7.09  | 9.51  | 7.97  | 6.48  | 3.41  | 3.21  | 3.60  |
| <b>Cs</b>                  | <0.1  | <0.1  | <0.1  | 0.90  | 0.15  | 0.11  | <0.1 | 0.82  | 0.30  | 0.22  | 0.15  | 0.30  | 0.26  | 0.15  | <0.1  |
| <b>Ta</b>                  | 0.057 | 0.057 | 0.12  | 0.14  | <0.05 | <0.05 | 0.09 | 0.06  | 0.06  | 0.06  | <0.05 | 0.11  | <0.05 | 0.06  | <0.05 |
| <b>Hf</b>                  | 0.51  | 0.61  | 1.03  | 1.25  | 0.15  | 0.18  | 0.11 | 0.58  | 0.39  | 0.49  | 0.43  | 0.91  | 0.19  | 0.29  | 0.20  |
| <b>Th</b>                  | 0.45  | 0.41  | 1.34  | 2.63  | 0.13  | 0.10  | 0.06 | 1.24  | 0.76  | 0.57  | 0.64  | 1.17  | 0.13  | 0.38  | 0.22  |
| <b>U</b>                   | 0.12  | 0.076 | 0.29  | 0.52  | 0.04  | 0.03  | 0.02 | 0.29  | 0.15  | 0.10  | 0.14  | 0.20  | 0.04  | 0.09  | 0.04  |
| <b>Total REE</b>           | 12.56 | 18.88 | 43.19 | 47.51 | 6.84  | 6.06  | 6.72 | 26.14 | 18.93 | 22.35 | 22.32 | 25.92 | 6.83  | 11.60 | 8.41  |
| <b>LREE</b>                | 8.20  | 14.29 | 36.80 | 42.63 | 5.57  | 4.72  | 5.38 | 23.53 | 15.68 | 18.26 | 18.84 | 22.65 | 5.23  | 10.25 | 6.88  |
| <b>HREE</b>                | 4.37  | 4.59  | 6.39  | 4.87  | 1.27  | 1.35  | 1.35 | 2.61  | 3.25  | 4.09  | 3.48  | 3.27  | 1.59  | 1.35  | 1.53  |
| <b>Eu/Eu*</b>              | 0.85  | 0.68  | 0.73  | 0.80  | 1.10  | 1.05  | 1.45 | 1.18  | 1.02  | 1.01  | 1.18  | 0.68  | 1.13  | 1.00  | 1.56  |
| <b>(La/Yb)<sub>n</sub></b> | 0.41  | 1.58  | 3.31  | 5.56  | 2.19  | 1.67  | 2.01 | 5.84  | 2.87  | 2.30  | 3.10  | 4.16  | 1.57  | 4.65  | 2.41  |