

Supplementary Data, Table A: Representative electron microprobe analyses of olivines and Cr-spinels from Avachinsky veined mantle xenoliths and temperatures calculated using olivine-spinel geothermometry (Ballhaus et al. 1991)

| <b>Sample #</b>                          | AVX-60  | AVX-60  | AVX-60  | AVX-61  | AVX-61  | AVX-61  | AVX-60    | AVX-60    | AVX-61    | AVX-61    |
|--|---------|---------|---------|---------|---------|---------|-----------|-----------|-----------|-----------|
| <b>Mineral</b>                           | olivine | olivine | olivine | olivine | olivine | olivine | Cr-spinel | Cr-spinel | Cr-spinel | Cr-spinel |
| <b>Analysis #</b>                        | 191n    | 24n     | 30      | 8       | 294n    | 12      | 94        | 112       | 72        | 88        |
| <b>Major elements (wt.%):</b>            |         |         |         |         |         |         |           |           |           |           |
| SiO <sub>2</sub>                         | 40.91   | 41.35   | 40.65   | 40.97   | 40.82   | 40.66   | 0.04      | 0.04      | 0.02      | 0.03      |
| TiO <sub>2</sub>                         | 0.00    | 0.01    | 0.01    | 0.00    | 0.02    | 0.00    | 0.01      | 0.06      | 0.01      | 0.07      |
| Al <sub>2</sub> O <sub>3</sub>           | 0.00    | 0.01    | 0.02    | 0.01    | 0.02    | 0.00    | 14.51     | 14.49     | 18.70     | 17.36     |
| Cr <sub>2</sub> O <sub>3</sub>           | 0.02    | 0.01    | 0.00    | 0.00    | 0.00    | 0.02    | 52.83     | 49.98     | 48.78     | 51.32     |
| NiO                                      | 0.43    | 0.34    | 0.47    | 0.34    | 0.36    | 0.34    | n.a.      | n.a.      | n.a.      | n.a.      |
| FeO                                      | 9.69    | 9.27    | 8.97    | 8.46    | 8.92    | 8.36    | 19.88     | 23.18     | 18.78     | 17.89     |
| MnO                                      | 0.15    | 0.17    | 0.00    | 0.10    | 0.10    | 0.04    | 0.22      | 0.21      | 0.19      | 0.22      |
| MgO                                      | 49.34   | 49.59   | 49.81   | 49.72   | 49.99   | 49.98   | 12.24     | 12.03     | 12.99     | 12.68     |
| CaO                                      | 0.018   | 0.018   | 0.04    | 0.03    | 0.023   | 0.03    | 0.00      | 0.00      | 0.00      | 0.01      |
| <b>Total</b>                             | 100.55  | 100.77  | 99.97   | 99.63   | 100.24  | 99.43   | 99.74     | 100.00    | 99.47     | 99.58     |
| <b>Cationic proportions<sup>1</sup>:</b> |         |         |         |         |         |         |           |           |           |           |
| Si                                       | 1.00    | 1.00    | 0.99    | 1.00    | 1.00    | 1.00    | 0.00      | 0.00      | 0.00      | 0.00      |
| Al                                       | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.55      | 0.54      | 0.69      | 0.64      |
| Ti                                       | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00      | 0.00      | 0.00      | 0.00      |
| Cr                                       | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 1.33      | 1.26      | 1.21      | 1.28      |
| Fe <sup>3+</sup>                         |         |         |         |         |         |         | 0.12      | 0.19      | 0.10      | 0.07      |
| Mg                                       | 1.79    | 1.79    | 1.82    | 1.81    | 1.82    | 1.83    | 0.58      | 0.57      | 0.61      | 0.60      |
| Fe <sup>2+</sup>                         | 0.20    | 0.19    | 0.18    | 0.17    | 0.18    | 0.17    | 0.41      | 0.43      | 0.39      | 0.40      |
| Mn                                       | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.01      | 0.01      | 0.01      | 0.01      |
| Ni                                       | 0.01    | 0.01    | 0.01    | 0.01    | 0.01    | 0.01    |           |           |           |           |
| Ca                                       | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00      | 0.00      | 0.00      | 0.00      |
| <b>Sum</b>                               | 3.00    | 3.00    | 3.01    | 3.00    | 3.00    | 3.00    | 3.00      | 3.00      | 3.00      | 3.00      |
| Mg# = Mg/(Mg+Fe <sup>2+</sup> )          | 0.901   | 0.905   | 0.908   | 0.913   | 0.909   | 0.914   | 0.585     | 0.573     | 0.608     | 0.598     |
| Cr# = Cr/(Cr+Al)                         |         |         |         |         |         |         | 0.710     | 0.698     | 0.636     | 0.665     |
| <b>Olivine-spinel</b>                    |         |         |         |         |         |         |           |           |           |           |
| Mg# of corresponding olivine             |         |         |         |         |         |         | 0.908     | 0.908     | 0.913     | 0.913     |
| T (°C) @ 2 GPa (BBG'91)                  |         |         |         |         |         |         | 1054      | 1109      | 1006      | 949       |

<sup>1</sup> Cationic proportions for olivine and Cr-spinel based on 3 cations and 4 oxygens; Fe<sup>3+</sup> in Cr-spinel was calculated assuming perfect stoichiometry.

n.a. = not analyzed

Supplementary Data, Table B: Representative electron microprobe analyses of orthopyroxenes from Avachinsky veined mantle xenoliths and temperatures calculated based on Ca-in-opx geothermometry (Brey and Köhler 1990)

| <b>Sample #</b>                          | AVX-60      | AVX-60      | AVX-60      | AVX-61      | AVX-61      | AVX-61      | AVX-60v | AVX-60v | AVX-60v | AVX-61v | AVX-61v | AVX-61v |
|--|-------------|-------------|-------------|-------------|-------------|-------------|---------|---------|---------|---------|---------|---------|
| <b>Sample type</b>                       | harzburgite | harzburgite | harzburgite | harzburgite | harzburgite | harzburgite | vein    | vein    | vein    | vein    | vein    | vein    |
| <b>Mineral</b>                           | Opx         | Opx         | Opx         | Opx         | Opx         | Opx         | Opx     | Opx     | Opx     | Opx     | Opx     | Opx     |
| <b>Analysis #</b>                        | 63          | 69          | 81n         | 61          | 76          | 377n        | 86      | 125     | 266n    | 51      | 56      | 459n    |
| <b>Major elements (wt.%):</b>            |             |             |             |             |             |             |         |         |         |         |         |         |
| SiO <sub>2</sub>                         | 55.88       | 56.13       | 57.80       | 56.61       | 56.96       | 57.27       | 56.95   | 57.26   | 57.66   | 57.72   | 56.65   | 57.15   |
| TiO <sub>2</sub>                         | 0.00        | 0.00        | 0.01        | 0.02        | 0.03        | 0.02        | 0.02    | 0.04    | 0.01    | 0.00    | 0.01    | 0.01    |
| Al <sub>2</sub> O <sub>3</sub>           | 1.12        | 1.14        | 1.21        | 1.48        | 1.19        | 1.28        | 0.99    | 0.76    | 0.95    | 0.79    | 2.53    | 1.21    |
| Cr <sub>2</sub> O <sub>3</sub>           | 0.28        | 0.19        | 0.56        | 0.55        | 0.53        | 0.49        | 0.15    | 0.20    | 0.41    | 0.38    | 0.43    | 0.29    |
| NiO                                      | n.a.        | n.a.        | 0.09        | n.a.        | n.a.        | 0.07        | n.a.    | n.a.    | 0.08    | n.a.    | n.a.    | 0.10    |
| FeO                                      | 6.36        | 6.11        | 6.04        | 6.63        | 6.54        | 6.04        | 6.98    | 7.16    | 6.47    | 4.31    | 5.93    | 6.28    |
| MnO                                      | 0.12        | 0.13        | 0.18        | 0.07        | 0.09        | 0.14        | 0.17    | 0.12    | 0.21    | 0.02    | 0.09    | 0.15    |
| MgO                                      | 34.57       | 35.17       | 33.61       | 34.44       | 34.67       | 34.59       | 35.13   | 34.30   | 34.27   | 35.98   | 34.83   | 34.32   |
| CaO                                      | 0.74        | 0.58        | 0.67        | 0.49        | 0.62        | 0.62        | 0.54    | 0.69    | 0.58    | 0.70    | 0.24    | 0.50    |
| Na <sub>2</sub> O                        | 0.03        | 0.04        | 0.05        | 0.00        | 0.00        | 0.01        | 0.00    | 0.02    | 0.01    | 0.02    | 0.03    | 0.00    |
| <b>Total</b>                             | 99.10       | 99.49       | 100.22      | 100.29      | 100.63      | 100.53      | 100.91  | 100.54  | 100.65  | 99.92   | 100.73  | 100.01  |
| <b>Cationic proportions<sup>1</sup>:</b> |             |             |             |             |             |             |         |         |         |         |         |         |
| Si                                       | 1.94        | 1.94        | 2.00        | 1.95        | 1.95        | 1.96        | 1.94    | 1.97    | 1.98    | 1.97    | 1.93    | 1.97    |
| Al                                       | 0.05        | 0.05        | 0.05        | 0.06        | 0.05        | 0.05        | 0.04    | 0.03    | 0.04    | 0.03    | 0.10    | 0.05    |
| Ti                                       | 0.00        | 0.00        | 0.00        | 0.00        | 0.00        | 0.00        | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    |
| Cr                                       | 0.01        | 0.01        | 0.02        | 0.01        | 0.01        | 0.01        | 0.00    | 0.01    | 0.01    | 0.01    | 0.01    | 0.01    |
| Fe <sup>3+</sup>                         | 0.07        | 0.08        | 0.00        | 0.03        | 0.03        | 0.01        | 0.07    | 0.03    | 0.00    | 0.01    | 0.02    | 0.00    |
| Mg                                       | 1.79        | 1.81        | 1.73        | 1.77        | 1.77        | 1.77        | 1.79    | 1.76    | 1.75    | 1.83    | 1.77    | 1.76    |
| Fe <sup>2+</sup>                         | 0.12        | 0.10        | 0.17        | 0.16        | 0.16        | 0.17        | 0.13    | 0.18    | 0.19    | 0.11    | 0.15    | 0.18    |
| Mn                                       | 0.00        | 0.00        | 0.01        | 0.00        | 0.00        | 0.00        | 0.00    | 0.00    | 0.01    | 0.00    | 0.00    | 0.00    |
| Ni                                       |             |             | 0.00        |             |             | 0.00        |         |         | 0.00    |         |         | 0.00    |
| Ca                                       | 0.03        | 0.02        | 0.02        | 0.02        | 0.02        | 0.02        | 0.02    | 0.03    | 0.02    | 0.03    | 0.01    | 0.02    |
| Na                                       | 0.00        | 0.00        | 0.00        | 0.00        | 0.00        | 0.00        | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    |
| <b>Sum</b>                               | 4.00        | 4.00        | 4.00        | 4.00        | 4.00        | 4.00        | 4.00    | 4.00    | 4.00    | 4.00    | 4.00    | 4.00    |
| Mg# = Mg/(Mg+Fe <sup>2+</sup> )          | 0.939       | 0.949       | 0.908       | 0.916       | 0.919       | 0.914       | 0.931   | 0.907   | 0.904   | 0.943   | 0.924   | 0.907   |
| T (°C) Ca-in-opx (BK'90)                 | 1006        | 951         | 980         | 915         | 964         | 961         | 931     | 987     | 948     | 990     | 782     | 919     |

<sup>1</sup> Cationic proportions for orthopyroxene based on 4 cations and 6 oxygens.

n.a. = not analyzed

Supplementary Data, Table C: Representative electron microprobe analyses of clinopyroxenes and amphiboles from Avachinsky veined mantle xenoliths and temperatures calculated based on 2-pyroxene geothermometry (Brey and Köhler 1990)

| <b>Sample #</b>                          | AVX-60v | AVX-60v | AVX-60v | AVX-60v | AVX-61v | AVX-61v | AVX-61v | AVX-61v | AVX-61v | AVX-61v |
|--|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| <b>Sample type</b>                       | vein    | vein    | vein    | vein    | vein    | vein    | vein    | vein    | vein    | vein    |
| <b>Mineral</b>                           | Cpx     | Cpx     | Cpx     | Cpx     | Cpx     | Cpx     | Cpx     | Cpx     | Amph    | Amph    |
| <b>Analysis #</b>                        | 83      | 120     | 207n    | 212n    | 29      | 31      | 401n    | 404n    | 45      | 57      |
| <b>Major elements (wt.%):</b>            |         |         |         |         |         |         |         |         |         |         |
| SiO <sub>2</sub>                         | 53.82   | 53.82   | 54.97   | 54.57   | 53.21   | 53.82   | 54.89   | 54.58   | 48.91   | 48.14   |
| TiO <sub>2</sub>                         | 0.03    | 0.00    | 0.04    | 0.04    | 0.03    | 0.03    | 0.00    | 0.06    | 0.10    | 0.12    |
| Al <sub>2</sub> O <sub>3</sub>           | 0.70    | 1.01    | 0.92    | 1.02    | 1.94    | 1.72    | 0.92    | 1.20    | 9.43    | 9.77    |
| Cr <sub>2</sub> O <sub>3</sub>           | 0.25    | 0.59    | 0.72    | 0.59    | 0.98    | 0.86    | 0.46    | 0.62    | 1.30    | 2.38    |
| FeO                                      | 2.47    | 2.69    | 2.13    | 2.28    | 2.48    | 2.20    | 2.07    | 2.39    | 3.47    | 3.26    |
| MnO                                      | 0.07    | 0.07    | 0.08    | 0.11    | 0.06    | 0.06    | 0.11    | 0.12    | 0.03    | 0.02    |
| MgO                                      | 18.48   | 17.46   | 17.65   | 17.65   | 17.40   | 17.67   | 18.07   | 17.78   | 20.17   | 19.62   |
| CaO                                      | 23.22   | 24.13   | 22.93   | 23.40   | 23.07   | 23.41   | 23.35   | 23.20   | 12.36   | 12.37   |
| Na <sub>2</sub> O                        | 0.24    | 0.13    | 0.30    | 0.19    | 0.33    | 0.33    | 0.15    | 0.19    | 1.71    | 1.80    |
| K <sub>2</sub> O                         | n.a.    | n.a.    | 0.00    | 0.00    | n.a.    | n.a.    | 0.00    | 0.03    | 0.31    | 0.41    |
| <b>Total</b>                             | 99.28   | 99.90   | 99.72   | 99.85   | 99.51   | 100.09  | 100.02  | 100.17  | 97.77   | 97.89   |
| <b>Cationic proportions<sup>1</sup>:</b> |         |         |         |         |         |         |         |         |         |         |
| Si                                       | 1.96    | 1.96    | 2.00    | 1.98    | 1.94    | 1.94    | 1.99    | 1.98    | 6.83    | 6.76    |
| Al                                       | 0.03    | 0.05    | 0.04    | 0.04    | 0.08    | 0.08    | 0.04    | 0.05    | 1.55    | 1.62    |
| Ti                                       | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.01    | 0.01    |
| Cr                                       | 0.01    | 0.02    | 0.02    | 0.02    | 0.03    | 0.03    | 0.01    | 0.02    | 0.14    | 0.26    |
| Fe <sup>3+</sup>                         | 0.06    | 0.03    | 0.00    | 0.00    | 0.03    | 0.04    | 0.00    | 0.00    | 0.10    | 0.02    |
| Mg                                       | 1.00    | 0.95    | 0.96    | 0.96    | 0.95    | 0.94    | 0.98    | 0.96    | 4.20    | 4.11    |
| Fe <sup>2+</sup>                         | 0.02    | 0.05    | 0.06    | 0.07    | 0.04    | 0.03    | 0.06    | 0.07    | 0.31    | 0.37    |
| Mn                                       | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    | 0.00    |
| Ca                                       | 0.91    | 0.93    | 0.89    | 0.91    | 0.90    | 0.92    | 0.91    | 0.90    | 1.85    | 1.86    |
| Na                                       | 0.02    | 0.01    | 0.02    | 0.01    | 0.02    | 0.02    | 0.01    | 0.01    | 0.46    | 0.49    |
| K  |         |         | 0.00    | 0.00    |         |         | 0.00    | 0.00    | 0.06    | 0.07    |
| <b>Sum</b>                               | 4.00    | 4.00    | 4.00    | 4.00    | 4.00    | 4.00    | 4.00    | 4.00    | 15.52   | 15.56   |
| Mg# = Mg/(Mg+Fe <sup>2+</sup> )          | 0.985   | 0.950   | 0.937   | 0.932   | 0.957   | 0.970   | 0.940   | 0.930   | 0.932   | 0.918   |
| T (°C) Cpx-Opx (BK'90) <sup>2</sup>      | 886     | 784     | 914     | 876     | 872     | 810     | 895     | 905     |         |         |

<sup>1</sup> Cationic proportions for clinopyroxene based on 4 cations and 6 oxygens; for amphibole, 15 cations (excluding Na and K) and 23 oxygens were assumed.

<sup>2</sup> Corresponding orthopyroxene compositions are: Fe# = 0.073, N<sub>Ca</sub> = 0.051, N<sub>Na</sub> = 0.001 for AVX-60v and Fe# = 0.071, N<sub>Ca</sub> = 0.014, N<sub>Na</sub> = 0.001 for AVX-61v.

n.a. = not analyzed