Supplement of

Unusual silicate mineralization in fumarolic sublimates of the Tolbachik volcano, Kamchatka, Russia – Part 1: Neso-, cyclo-, ino- and phyllosilicates

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Fig. S1. Chemical features for Ca-Mg-Fe pyroxenes (a, with magnified fragment) and feldspars (b) from basalts of Great Fissure Tolbachik Eruption 1975–1976: ● – our data; ☆ – data for magnesium basalts from (Fedotov and Markhinin, 1983); □ – data for subalkaline alumina-rich basalts from (Fedotov and Markhinin, 1983).
Table S1. Chemical composition of minerals and glass composing non-altered by fumarolic gas basalt scoria which hosts the Arsentnaya fumarole

| Component | Ol  | Cpx | Cpx | Cpx | Cpx | Cpx | Pl  | Pl  | Pl  | Pl  | Glass |
|-----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-------|
| SiO₂      | 41.86 | 50.39 | 45.87 | 50.45 | 47.45 | 48.63 | 50.98 | 50.15 | 50.30 | 50.85 | 53.09 |
| TiO₂      | 1.05  | 1.82  | 0.71  | 1.40  | 1.34  | 1.45  | 1.45  | 1.45  | 1.45  | 1.45  |       |
| Al₂O₃     | 3.66  | 8.03  | 3.12  | 5.63  | 4.27  | 31.61 | 32.00 | 31.96 | 31.19 | 15.17 |       |
| Cr₂O₃     | 0.13  | 0.43  |       |       |       |       |       |       |       |       |       |
| FeO*      | 0.77  | 9.33  | 8.87  | 9.28  | 9.94  | 0.99  | 1.05  | 0.99  | 1.08  | 12.99 |       |
| MnO       | 0.35  | 0.32  | 0.20  | 0.21  | 0.23  | 0.26  |       |       |       |       |       |
| NiO       | 0.24  |       |       |       |       |       |       |       |       |       |       |
| CuO       | 0.38  |       |       |       |       |       |       |       |       |       |       |
| MgO       | 56.23 | 16.18 | 12.87 | 17.63 | 13.95 | 15.14 | 0.24  | 0.23  | 0.26  | 0.23  | 4.26  |
| CaO       | 0.16  | 17.42 | 20.47 | 17.17 | 19.17 | 17.80 | 13.19 | 13.71 | 13.53 | 12.80 | 5.15  |
| Na₂O      | 0.36  | 0.30  | 0.19  | 0.33  | 0.38  | 3.73  | 3.39  | 3.58  | 3.87  | 5.02  |       |
| K₂O       | 0.07  |       |       |       | 0.17  | 0.13  | 0.13  | 1.23  |       |       |       |
| P₂O₅      |       |       |       |       |       |       |       |       |       | 0.38  |       |
| Total     | 99.99 | 98.91 | 98.43 | 98.15 | 97.41 | 97.76 | 100.91| 100.66| 100.62| 100.15| 98.74 |

| Empirical formulae |
|--------------------|
| Si    | 0.99 | 1.89 | 1.75 | 1.89 | 1.82 | 1.85 | 2.31 | 2.28 | 2.28 | 2.32 |
| Ti    | 0.03 | 0.05 | 0.02 | 0.04 | 0.04 |       |       |       |       |       |
| Al    | 0.16 | 0.36 | 0.14 | 0.25 | 0.19 | 1.68 | 1.71 | 1.71 | 1.67 |       |
| Cr    | 0.00 |       |       |       |       |       |       |       |       |       |
| Fe²⁺  | 0.02 | 0.29 | 0.28 | 0.26 | 0.30 | 0.32 | 0.04 | 0.04 | 0.04 | 0.04 |
| Mn    | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |       |       |       |       |       |
| Ni    | 0.00 |       |       |       |       |       |       |       |       |       |
| Cu    | 0.01 |       |       |       |       |       |       |       |       |       |
| Mg    | 1.98 | 0.90 | 0.73 | 0.99 | 0.80 | 0.86 | 0.02 | 0.02 | 0.02 | 0.02 |
| Ca    | 0.00 | 0.70 | 0.83 | 0.69 | 0.79 | 0.73 | 0.64 | 0.67 | 0.66 | 0.62 |
| Na    | 0.03 | 0.02 | 0.01 | 0.03 | 0.03 | 0.33 | 0.30 | 0.31 |       | 0.34 |
| K     | 0.00 |       |       |       |       |       |       |       |       |       |
| Σ extr | 3.01 | 4.02 | 4.03 | 4.02 | 4.03 | 4.03 | 5.02 | 5.02 | 5.02 | 5.02 |
| O (BoFC) | 4  | 6  | 6  | 6  | 6  | 6  | 8  | 8  | 8  | 8  |       |

Ol – olivine (forsterite), Cpx – clinopyroxene (Al- and Fe-bearing diopside), Pl – plagioclase (labrador); empty cell means content below detection limit; Σ extr = sum of metal cations + Si; O (BoFC) is a basis of formula calculation, number of O atoms per formula unit; *¹all iron is calculated as Fe²⁺.
Table S2. Typical chemical composition of indialite (Ind), enstatite (En), diopside (Di), fluorophlogopite (FPhlg) from Mountain 1004.

| Component | Ind | En | En | Di | FPhlg | FPhlg | FPhlg | FPhlg |
|-----------|-----|----|----|----|-------|-------|-------|-------|
| SiO₂      | 48.40 | 56.82 | 57.02 | 50.72 | 43.42 | 44.33 | 44.68 | 44.25 | 43.53 |
| TiO₂      | -    | 0.08 | 0.14 | 0.48 | 2.12 | 1.18 | 1.19 | 0.69 | 1.75 |
| Al₂O₃     | 37.51 | 1.90 | 2.85 | 3.31 | 11.83 | 10.88 | 9.77 | 9.48 | 10.13 |
| Fe₂O₃     | 0.55 | 2.74 | 2.61 | 5.76 | 1.65 | 1.38 | 5.94 | 3.46 | 5.75 |
| MnO       | -    | 0.79 | 0.58 | 0.48 | -   | -   | -   | 0.03 | -    |
| CuO       | -    | 0.28 | 0.34 | -   | -   | 0.20 | 2.16 | 5.86 | 0.44 |
| ZnO       | -    | -    | -   | -   | -   | 0.73 | 1.08 | -    | -    |
| MgO       | 13.77 | 36.45 | 35.97 | 16.48 | 26.66 | 26.98 | 21.46 | 21.12 | 22.62 |
| CaO       | 0.06 | 1.43 | 1.12 | 21.31 | -   | 0.10 | 0.08 | 0.06 | 0.12 |
| Na₂O      | -    | -    | 0.16 | 0.76 | 0.86 | 0.84 | 0.42 | 0.45 | 0.49 |
| K₂O       | -    | -    | 0.16 | -   | 10.24 | 10.01 | 10.06 | 9.77 | 9.78 |
| F         | -    | -    | -   | 7.83 | 8.06 | 8.27 | 8.25 | 8.15 |
| Cl         | -    | -    | -   | 0.05 | 0.10 | 0.09 | 0.08 | 0.11 |
| O=(F,Cl₂) | 3.31 | 3.42 | 3.50 | 3.49 | 3.49 | 3.46 |

| Total      | 100.29 | 100.49 | 100.95 | 99.30 | 101.35 | 100.64 | 101.35 | 101.09 | 99.41 |

Empirical formulae

| Si  | 4.73 | 1.93 | 1.92 | 1.86 | 3.02 | 3.10 | 3.17 | 3.18 | 3.11 |
| Ti  | -    | 0.00 | 0.00 | 0.01 | 0.11 | 0.06 | 0.06 | 0.04 | 0.09 |
| Al  | 4.32 | 0.08 | 0.11 | 0.14 | 0.97 | 0.90 | 0.82 | 0.80 | 0.85 |
| Fe³⁺ | 0.04 | 0.07 | 0.07 | 0.16 | 0.09 | 0.07 | 0.32 | 0.19 | 0.31 |
| Mn  | -    | 0.02 | 0.02 | 0.01 | -   | -   | -   | 0.04 | -    |
| Cu  | -    | 0.01 | 0.01 | -   | -   | 0.01 | 0.12 | 0.32 | 0.02 |
| Zn  | -    | -    | -   | -   | -   | -   | 0.04 | 0.06 | -    |
| Mg  | 2.00 | 1.84 | 1.81 | 0.90 | 2.77 | 2.81 | 2.27 | 2.27 | 2.41 |
| Ca  | 0.01 | 0.05 | 0.04 | 0.84 | -   | 0.01 | 0.01 | 0.00 | 0.01 |
| Na  | -    | -    | 0.01 | 0.06 | 0.12 | 0.12 | 0.06 | 0.07 | 0.07 |
| K  | -    | -    | 0.01 | -   | 0.91 | 0.89 | 0.91 | 0.90 | 0.89 |
| F  | -    | -    | -   | 1.73 | 1.78 | 1.85 | 1.88 | 1.84 |
| Cl  | -    | -    | -   | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Σcat | 11.09 | 4.00 | 4.00 | 3.99 | 7.99 | 7.97 | 7.76 | 7.83 | 7.77 |
| BoFC | 18 O | 6 O | 6 O | 6 O | 1 O | 1 O | 1 O | 1 O | 1 O |

Note. Dash means the content below the detection limit. Σcat = sum of metal cations + Si. BoFC is a basis of formula calculation: number of O atoms per formula unit (apfu), except of micas (*) for which BoFC is O+F = 12 apfu.
