**SUPPORTING INFORMATION**

**Supplementary Table 2.** Incidence of toxicity caused by the heavy metals after comparison with consensus-based TEL and PEL values of the SQG (MacDonald et al., 2000)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Element** | **Toxicity (%)** | | | | | | | | |
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** |
| **Cr** | 15.4 | 15.4 | 15.4 | 15.4 | 15.4 | 15.4 | 3.5 | 15.4 | 15.4 |
| **Cu** | 21.9 | 21.9 | 21.9 | 21.9 | 21.9 | 21.9 | 21.9 | 21.9 | 21.9 |
| **Pb** | 5.8 | 5.8 | 5.8 | 5.8 | 5.8 | 5.8 | 5.8 | 5.8 | 5.8 |
| **Ni** | 8.4 | 8.4 | 8.4 | 8.4 | 8.4 | 3.3 | 3.3 | 3.3 | 8.4 |
| **Zn** | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 |

**Supplementary Table 3.** 10th to 100th percentile of each of the elements with greater than 0.700 absolute factor loadings according to PCA

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Percentile** | **Al** | **Br** | **Ca** | **Cl** | **Cr** | **Cu** | **Fe** | **K** | **Mg** | **Na** | **Pb** | **S** | **Si** | **Sr** | **Ti** |
| 10 | 16160 | 126 | 5474 | 97860 | 51.7 | 64.1 | 38000 | 2110 | 1028 | 85200 | 12.1 | 5633 | 36304 | 102 | 2006 |
| 20 | 17160 | 136 | 5846 | 128400 | 55.9 | 68.1 | 38500 | 2338 | 1394 | 309200 | 13.1 | 6606 | 39320 | 107 | 2619 |
| 30 | 19480 | 141 | 6843 | 148800 | 62.1 | 70.2 | 40540 | 2756 | 2140 | 448800 | 13.5 | 7274 | 48640 | 114 | 3046 |
| 40 | 23500 | 149 | 8094 | 167400 | 68.4 | 71.7 | 43320 | 3529 | 3750 | 451600 | 14.1 | 7474 | 63018 | 120 | 3132 |
| 50 | 29500 | 171 | 8220 | 189000 | 71.4 | 73.9 | 43400 | 4660 | 4760 | 458000 | 14.3 | 7530 | 75890 | 124 | 3140 |
| 60 | 30380 | 175 | 9804 | 197800 | 71.5 | 75.2 | 44120 | 4796 | 5460 | 533200 | 15.4 | 7666 | 80874 | 126 | 3372 |
| 70 | 31800 | 180 | 11100 | 200000 | 92.8 | 76.5 | 44780 | 4908 | 5985 | 558000 | 17.2 | 7826 | 84028 | 128 | 3502 |
| 80 | 40920 | 186 | 18300 | 204000 | 115 | 80.2 | 47620 | 5528 | 9264 | 572400 | 19.1 | 7914 | 106236 | 157 | 3758 |
| 90 | 56360 | 197 | 41450 | 220400 | 129 | 85.8 | 52440 | 6462 | 16434 | 595200 | 21.6 | 7968 | 140512 | 430 | 4338 |
| 100 | 68200 | 217 | 94450 | 262000 | 139 | 90.3 | 56600 | 6788 | 28180 | 624000 | 26.6 | 8160 | 152000 | 1350 | 5410 |

***Supplementary Table 4.*** *Calculation of the weight attribute of each of the elements with high factor loadings according to PCA*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **PC** | **Eigenvalue** | **Relative Eigenvalue** | **Element** | **Loading Value** | **Relative loading value on same PC** | **Weight (relative eigenvalue x relative loading value)** |
| 1 | 11.186 | 0.631 | Al | 0.944 | 0.089 | 0.056 |  |
| Ca | 0.830 | 0.078 | 0.050 |  |
| Fe | 0.933 | 0.088 | 0.056 |  |
| K | 0.920 | 0.087 | 0.055 |  |
| Mg | 0.869 | 0.082 | 0.052 |  |
| Si | 0.966 | 0.091 | 0.058 |  |
| Sr | 0.728 | 0.069 | 0.043 |  |
| Ti | 0.862 | 0.081 | 0.051 |  |
| Na | 0.984 | 0.093 | 0.059 |  |
| S | 0.902 | 0.085 | 0.054 |  |
| Br | 0.780 | 0.074 | 0.047 |  |
| Cl | 0.867 | 0.082 | 0.052 |  |
|  |  |  | Total | 10.586 | 1.000 |  |  |
|  |  |  |  |  |  |  |  |
| 2 | 3.973 | 0.224 | Cu | 0.875 | 0.475 | 0.107 |  |
| Cr | 0.967 | 0.525 | 0.118 |  |
|  |  |  | Total | 1.842 | 1.000 |  |  |
|  |  |  |  |  |  |  |  |
| 3 | 2.557 | 0.144 | Pb | 0.713 | 0.469 | 0.068 |  |
| Rb | 0.807 | 0.531 | 0.077 |  |
|  |  |  | Total | 1.520 | 1.000 |  |  |
| Total | 17.716 |  |  |  |  |  |  |

**Supplementary Table 5.** Elemental factor loadings and contribution of the first five principal components

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **PC 1** | | **PC 2** | | **PC 3** | | **PC 4** | | **PC 5** | |
| Eigenvalues | 11.186 | | 3.973 | | 2.557 | | 2.026 | | 0.918 | |
| Proportion of Variance (%) | 50.847 | | 18.059 | | 11.623 | | 9.209 | | 4.172 | |
| Source | Terrestrial | | Industrial | | Pyrotechnics | |  | |  | |
| **Element** | **Factor Loading** | **Contribution (%)** | **Factor Loading** | **Contribution (%)** | **Factor Loading** | **Contribution (%)** | **Factor Loading** | **Contribution (%)** | **Factor Loading** | **Contribution (%)** |
| Na | -0.984 | 8.663 | -0.103 | 0.266 | 0.072 | 0.203 | 0.020 | 0.021 | -0.022 | 0.052 |
| Mg | 0.869 | 6.747 | 0.082 | 0.168 | -0.247 | 2.378 | 0.300 | 4.439 | -0.152 | 2.512 |
| Al | 0.944 | 7.958 | 0.090 | 0.205 | 0.087 | 0.294 | -0.294 | 4.261 | 0.035 | 0.131 |
| Si | 0.966 | 8.346 | -0.041 | 0.042 | 0.054 | 0.114 | -0.214 | 2.266 | 0.029 | 0.091 |
| S | -0.902 | 7.274 | -0.282 | 1.999 | 0.164 | 1.057 | 0.011 | 0.007 | 0.241 | 6.303 |
| Cl | -0.867 | 6.724 | -0.025 | 0.016 | -0.314 | 3.867 | 0.146 | 1.051 | -0.247 | 6.624 |
| K | 0.920 | 7.568 | -0.274 | 1.884 | -0.014 | 0.008 | -0.186 | 1.704 | -0.066 | 0.479 |
| Ca | 0.830 | 6.158 | 0.119 | 0.359 | -0.315 | 3.887 | 0.384 | 7.274 | -0.180 | 3.528 |
| Ti | 0.862 | 6.637 | -0.091 | 0.210 | 0.380 | 5.639 | -0.312 | 4.799 | -0.038 | 0.161 |
| Cr | -0.159 | 0.226 | -0.967 | 23.536 | 0.028 | 0.031 | -0.119 | 0.701 | 0.108 | 1.259 |
| Mn | -0.036 | 0.011 | 0.617 | 9.579 | 0.020 | 0.016 | 0.550 | 14.944 | 0.445 | 21.599 |
| Fe | 0.933 | 7.785 | 0.016 | 0.007 | 0.286 | 3.189 | -0.114 | 0.639 | 0.082 | 0.729 |
| Ni | -0.697 | 4.342 | -0.102 | 0.260 | -0.331 | 4.289 | -0.382 | 7.185 | 0.237 | 6.121 |
| Cu | 0.241 | 0.519 | 0.875 | 19.284 | 0.059 | 0.134 | -0.147 | 1.064 | 0.309 | 10.421 |
| Zn | 0.221 | 0.437 | -0.592 | 8.810 | 0.404 | 6.397 | 0.557 | 15.292 | 0.174 | 3.302 |
| Pb | -0.265 | 0.628 | 0.183 | 0.847 | 0.713 | 19.860 | 0.563 | 15.646 | -0.097 | 1.029 |
| Br | -0.780 | 5.445 | 0.214 | 1.154 | 0.402 | 6.312 | 0.007 | 0.002 | -0.185 | 3.747 |
| Rb | -0.050 | 0.023 | 0.400 | 4.028 | -0.807 | 25.498 | 0.013 | 0.008 | 0.222 | 5.371 |
| Sr | 0.728 | 4.738 | 0.097 | 0.237 | -0.391 | 5.987 | 0.497 | 12.215 | -0.214 | 5.008 |
| Y | 0.676 | 4.088 | -0.645 | 10.475 | -0.203 | 1.615 | 0.038 | 0.072 | 0.057 | 0.354 |
| Zr | 0.691 | 4.267 | 0.449 | 5.083 | 0.464 | 8.408 | -0.155 | 1.190 | 0.141 | 2.161 |
| Mo | -0.398 | 1.414 | 0.677 | 11.551 | 0.145 | 0.818 | -0.325 | 5.222 | -0.418 | 19.018 |

**Supplementary Table 6.** Contribution of the principal components in each of the sampling locations (%)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sampling Location** | **Contribution (%)** | | | | |
| **PC 1** | **PC 2** | **PC 3** | **PC 4** | **PC 5** |
| 1 | 0.153 | 37.479 | 0.001 | 0.094 | 28.611 |
| 2 | 0.442 | 17.573 | 0.258 | 1.876 | 6.579 |
| 3 | 0.277 | 4.968 | 1.094 | 4.148 | 0.037 |
| 4 | 10.959 | 2.249 | 28.743 | 7.949 | 7.938 |
| 5 | 10.651 | 21.021 | 3.119 | 6.643 | 34.347 |
| 6 | 41.572 | 0.455 | 15.014 | 25.435 | 5.245 |
| 7 | 26.767 | 13.311 | 11.349 | 31.140 | 3.296 |
| 8 | 3.384 | 0.242 | 35.790 | 22.048 | 4.073 |
| 9 | 5.795 | 2.704 | 4.632 | 0.667 | 9.873 |

**Supplementary Table 7.** Correlation analysis of the composition of surface sediments

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | ***Na*** | ***Mg*** | ***Al*** | ***Si*** | ***S*** | ***Cl*** | ***K*** | ***Ca*** | ***Ti*** | ***Cr*** | ***Mn*** | ***Fe*** | ***Ni*** | ***Cu*** | ***Zn*** | ***Pb*** | ***Br*** | ***Rb*** | ***Sr*** | ***Y*** | ***Zr*** | ***Mo*** |
| **Na** | 1.00 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Mg** | -0.91 | 1.00 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Al** | -0.95 | *0.74* | 1.00 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Si** | -0.96 | *0.80* | *0.98* | 1.00 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **S** | *0.94* | -0.91 | -0.87 | -0.86 | 1.00 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Cl** | *0.86* | -0.64 | -0.90 | -0.92 | 0.68 | 1.00 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **K** | -0.90 | *0.83* | *0.91* | *0.95* | -0.80 | -0.80 | 1.00 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Ca** | -0.84 | *0.98* | 0.65 | *0.70* | -0.87 | -0.54 | 0.69 | 1.00 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Ti** | -0.82 | 0.59 | *0.92* | *0.93* | -0.70 | -0.91 | *0.87* | 0.48 | 1.00 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Cr** | 0.24 | -0.20 | -0.19 | -0.07 | 0.43 | 0.09 | 0.15 | -0.32 | -0.01 | 1.00 |  |  |  |  |  |  |  |  |  |  |  |  |
| **Mn** | -0.06 | 0.08 | -0.10 | -0.14 | -0.07 | -0.04 | -0.28 | 0.17 | -0.28 | -0.57 | 1.00 |  |  |  |  |  |  |  |  |  |  |  |
| **Fe** | -0.90 | 0.68 | *0.94* | *0.93* | -0.77 | -0.92 | *0.85* | 0.61 | *0.93* | -0.14 | -0.05 | 1.00 |  |  |  |  |  |  |  |  |  |  |
| **Ni** | 0.62 | -0.60 | -0.56 | -0.55 | 0.61 | 0.54 | -0.48 | -0.63 | -0.59 | 0.31 | -0.06 | -0.75 | 1.00 |  |  |  |  |  |  |  |  |  |
| **Cu** | -0.31 | 0.13 | 0.35 | 0.23 | -0.37 | -0.32 | -0.02 | 0.19 | 0.19 | -0.85 | 0.54 | 0.28 | -0.15 | 1.00 |  |  |  |  |  |  |  |  |
| **Zn** | -0.09 | 0.12 | 0.02 | 0.12 | 0.12 | -0.26 | 0.18 | 0.15 | 0.22 | 0.48 | -0.05 | 0.30 | -0.52 | -0.47 | 1.00 |  |  |  |  |  |  |  |
| **Pb** | 0.29 | -0.24 | -0.33 | -0.34 | 0.26 | 0.13 | -0.36 | -0.18 | -0.15 | -0.18 | 0.45 | -0.13 | -0.24 | 0.04 | 0.35 | 1.00 |  |  |  |  |  |  |
| **Br** | *0.77* | -0.80 | -0.70 | -0.72 | 0.68 | 0.50 | -0.77 | -0.68 | -0.51 | -0.08 | 0.08 | -0.67 | 0.42 | -0.04 | -0.17 | 0.52 | 1.00 |  |  |  |  |  |
| **Rb** | -0.02 | 0.09 | -0.10 | -0.14 | -0.10 | 0.25 | -0.23 | 0.20 | -0.40 | -0.41 | 0.25 | -0.21 | 0.16 | 0.35 | -0.41 | -0.58 | -0.26 | 1.00 |  |  |  |  |
| **Sr** | -0.74 | *0.95* | 0.51 | 0.58 | -0.80 | -0.40 | 0.58 | *0.98* | 0.33 | -0.30 | 0.21 | 0.48 | -0.58 | 0.11 | 0.16 | -0.14 | -0.63 | 0.24 | 1.00 |  |  |  |
| **Y** | -0.59 | 0.64 | 0.55 | 0.63 | -0.44 | -0.44 | *0.77* | 0.53 | 0.54 | 0.49 | -0.42 | 0.59 | -0.43 | -0.38 | 0.51 | -0.42 | -0.86 | -0.07 | 0.49 | 1.00 |  |  |
| **Zr** | -0.67 | 0.39 | *0.77* | 0.68 | -0.61 | -0.78 | 0.48 | 0.38 | *0.77* | -0.53 | 0.16 | *0.84* | -0.69 | 0.68 | 0.08 | 0.10 | -0.31 | -0.12 | 0.24 | 0.13 | 1.00 |  |
| **Mo** | 0.34 | -0.43 | -0.21 | -0.37 | 0.09 | 0.37 | -0.48 | -0.38 | -0.25 | -0.60 | 0.08 | -0.27 | 0.10 | 0.38 | -0.64 | 0.17 | 0.52 | 0.14 | -0.39 | -0.73 | 0.11 | 1.00 |