

Supplementary Materials

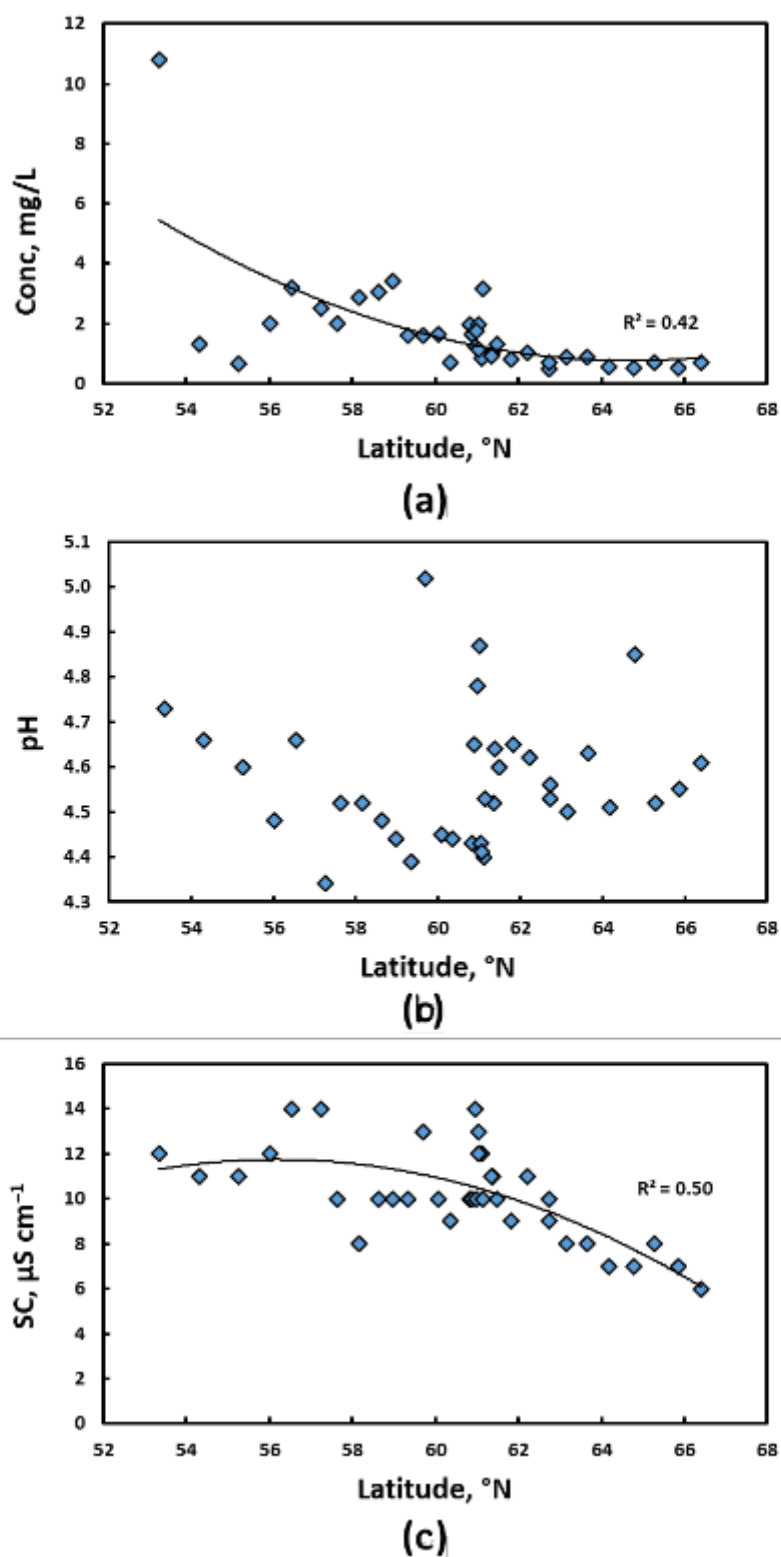


Figure S1. Examples of the concentration of SC, pH in snow water as a function of latitude.

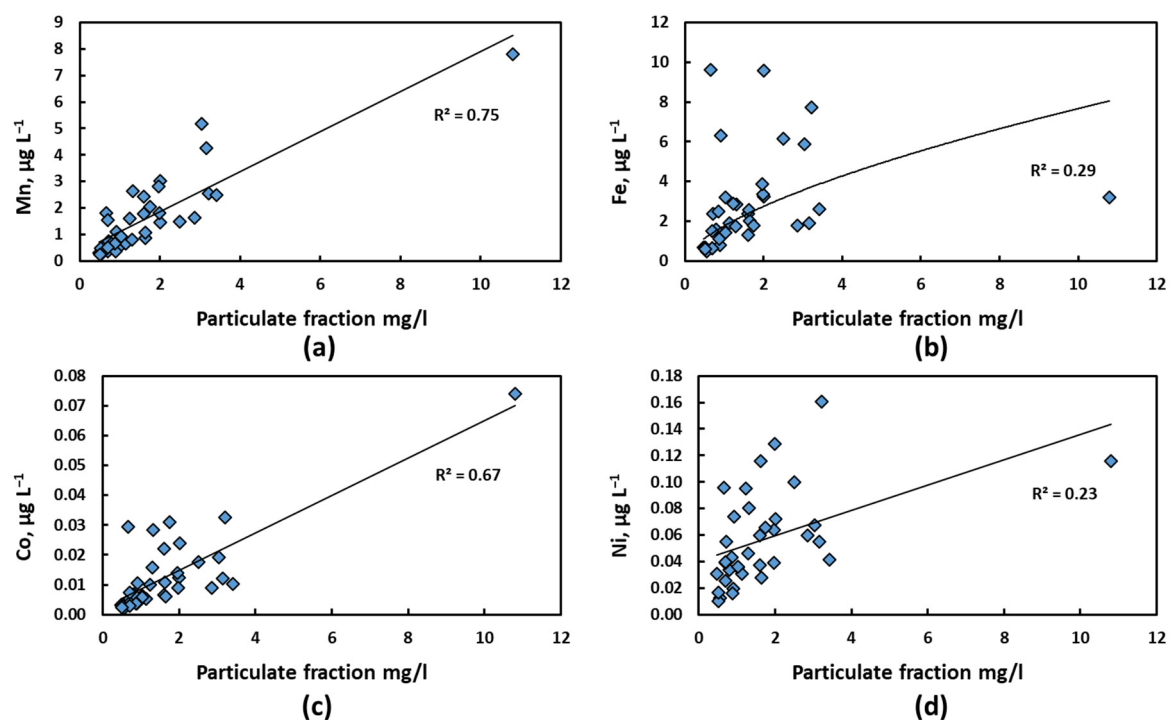


Figure S2. Examples of Mn, Fe, Co, and Ni in snow water as a function of particulate fraction.

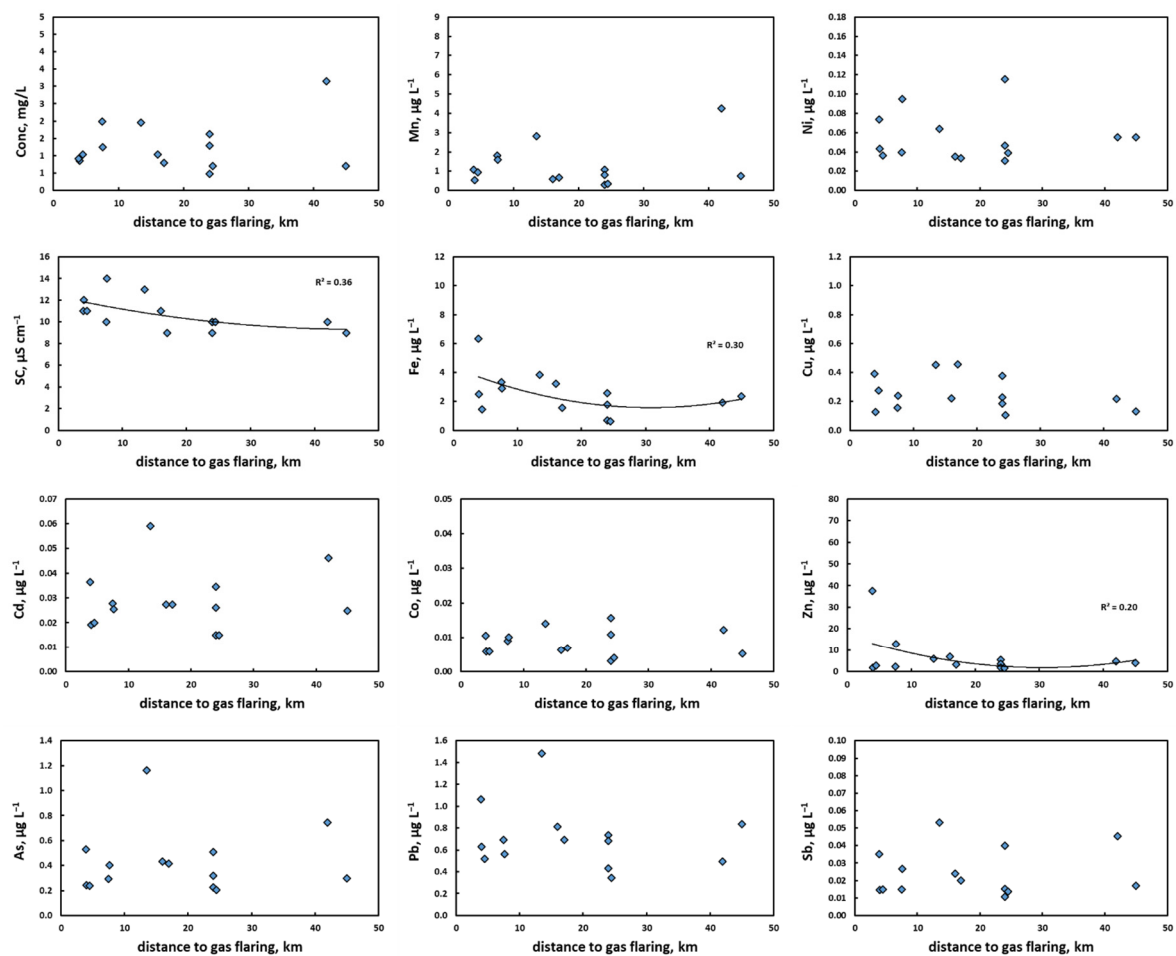


Figure S3. Examples of the concentration of SC, Mn, Ni, Fe, Cu, Cd, Co, Zn, As, Pb, and Sb in snow water as a function of distance to gas flaring.

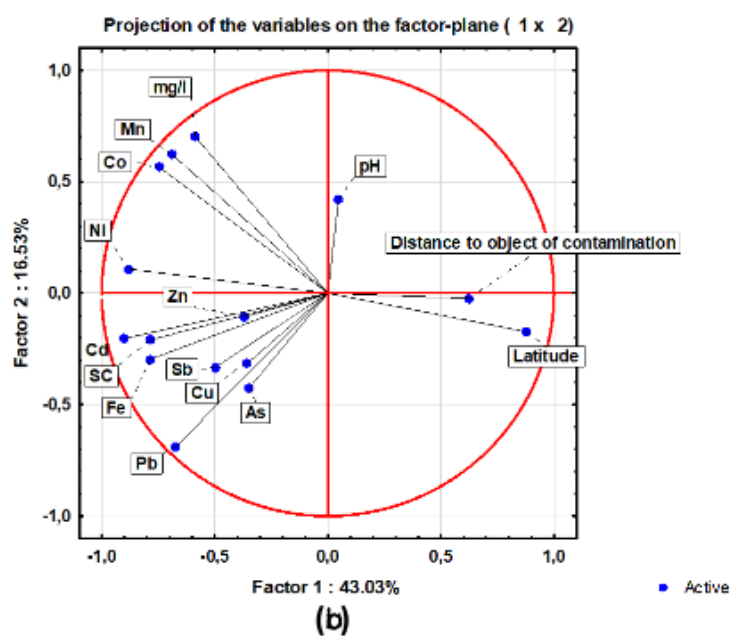
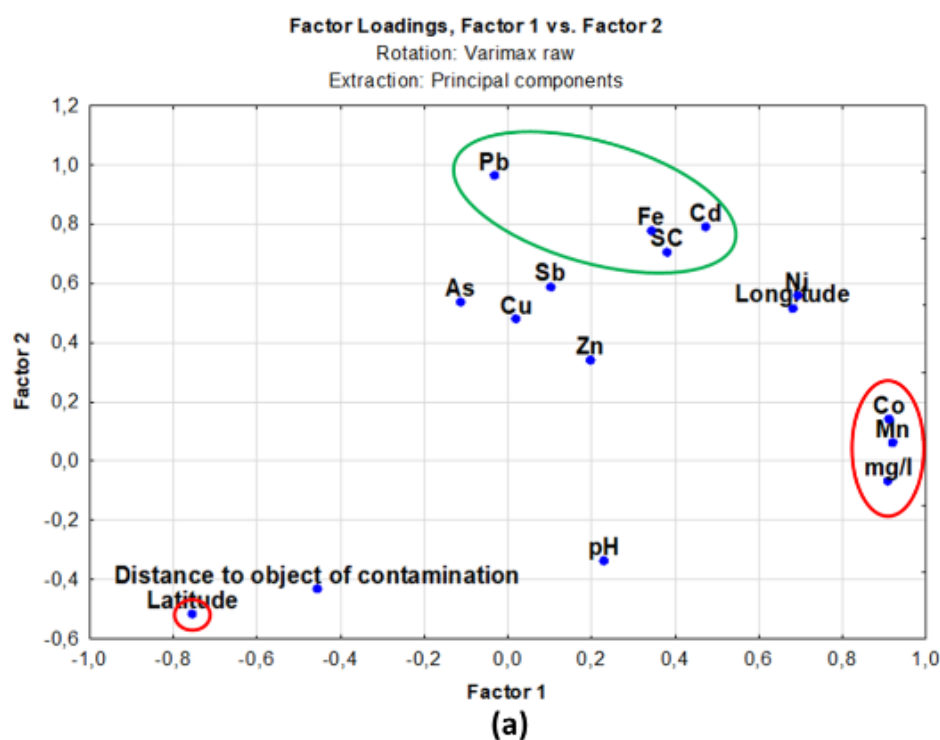


Figure S4. PCA factorial map $F1 \times F2$ of elements of a reconstructed table for the dissolved fraction.

Table S1. Physico-chemical properties of dissolved (< 0.22 µm) fraction of the snow water trace element concentrations (µg/L) in Western Siberia latitudinal transect

| Sample name | Latitude °N | Longitude °E | mg/l | pH | Specific Conducti-vity | Mn | Fe | Co | Ni | Cu | Zn | As | Cd | Sb | Pb |
|-------------|-------------|--------------|------|------|------------------------|------|------|-------|-------|------|-------|------|-------|-------|------|
| SN20-1 | 53.353110 | 84.115650 | 10.8 | 4.73 | 12 | 7.81 | 3.20 | 0.074 | 0.116 | 0.06 | 2.23 | 0.33 | 0.036 | 0.018 | 0.19 |
| SN20-2 | 54.313820 | 83.268000 | 1.3 | 4.66 | 11 | 2.63 | 2.84 | 0.028 | 0.080 | 0.36 | 3.07 | 0.29 | 0.037 | 0.029 | 0.67 |
| SN20-3 | 55.267670 | 82.721080 | 0.7 | 4.60 | 11 | 1.80 | 9.62 | 0.029 | 0.096 | 0.31 | 3.09 | 0.26 | 0.040 | 0.240 | 1.17 |
| SN20-4 | 56.030940 | 83.776950 | 2.0 | 4.48 | 12 | 1.47 | 9.56 | 0.024 | 0.072 | 0.25 | 2.93 | 0.32 | 0.044 | 0.054 | 1.15 |
| SN20-5 | 56.539973 | 84.059395 | 3.2 | 4.66 | 14 | 2.54 | 7.74 | 0.033 | 0.160 | 0.40 | 19.69 | 0.25 | 0.052 | 0.071 | 1.36 |
| SN20-6 | 57.253698 | 83.923628 | 2.5 | 4.34 | 14 | 1.50 | 6.15 | 0.018 | 0.100 | 0.23 | 22.14 | 0.25 | 0.044 | 0.032 | 1.30 |
| SN20-7 | 57.639776 | 83.551018 | 2.0 | 4.52 | 10 | 3.01 | 3.25 | 0.012 | 0.129 | 0.19 | 74.91 | 0.16 | 0.042 | 0.021 | 0.66 |
| SN20-8 | 58.165450 | 82.552152 | 2.9 | 4.52 | 8 | 1.63 | 1.80 | 0.009 | 0.060 | 0.96 | 19.99 | 0.15 | 0.027 | 0.013 | 0.50 |
| SN20-9 | 58.644013 | 81.665805 | 3.0 | 4.48 | 10 | 5.19 | 5.86 | 0.019 | 0.067 | 0.22 | 7.68 | 0.26 | 0.044 | 0.025 | 0.63 |
| SN20-10 | 58.980790 | 80.612990 | 3.4 | 4.44 | 10 | 2.50 | 2.59 | 0.010 | 0.041 | 0.13 | 2.95 | 0.24 | 0.038 | 0.017 | 0.51 |
| SN20-11 | 59.339339 | 79.765788 | 1.6 | 4.39 | 10 | 2.42 | 1.31 | 0.022 | 0.060 | 0.21 | 12.16 | 0.25 | 0.027 | 0.016 | 0.61 |
| SN20-12 | 59.696980 | 78.935680 | 1.6 | 5.02 | 13 | 1.77 | 2.36 | 0.007 | 0.038 | 0.13 | 4.97 | 0.25 | 0.030 | 0.016 | 0.59 |
| SN20-13 | 60.075950 | 78.135140 | 1.6 | 4.45 | 10 | 0.86 | 2.01 | 0.006 | 0.028 | 0.11 | 2.44 | 0.28 | 0.034 | 0.016 | 0.66 |
| SN20-14 | 60.353770 | 77.478310 | 0.7 | 4.44 | 9 | 0.75 | 2.36 | 0.005 | 0.055 | 0.13 | 4.12 | 0.30 | 0.025 | 0.017 | 0.84 |
| SN20-15 | 60.830600 | 77.240780 | 2.0 | 4.43 | 10 | 1.81 | 3.34 | 0.009 | 0.039 | 0.16 | 2.41 | 0.29 | 0.028 | 0.015 | 0.69 |
| SN20-16 | 61.116430 | 75.851770 | 0.9 | 4.40 | 12 | 0.55 | 2.48 | 0.006 | 0.043 | 0.13 | 1.81 | 0.24 | 0.019 | 0.015 | 0.63 |
| SN20-17 | 61.379444 | 74.916667 | 1.0 | 4.64 | 11 | 0.59 | 3.21 | 0.006 | 0.035 | 0.22 | 6.83 | 0.43 | 0.027 | 0.024 | 0.81 |
| SN20-18 | 61.343056 | 73.683333 | 0.9 | 4.52 | 11 | 1.09 | 6.32 | 0.010 | 0.074 | 0.39 | 37.65 | 0.53 | 0.037 | 0.035 | 1.06 |
| SN20-19 | 60.962170 | 72.538410 | 1.2 | 4.78 | 14 | 1.60 | 2.88 | 0.010 | 0.095 | 0.24 | 13.04 | 0.40 | 0.026 | 0.027 | 0.56 |
| SN20-20 | 60.879560 | 71.367550 | 1.6 | 4.65 | 10 | 1.07 | 2.57 | 0.011 | 0.116 | 0.23 | 5.43 | 0.32 | 0.026 | 0.015 | 0.74 |
| SN20-21 | 61.033490 | 69.985940 | 2.0 | 4.43 | 13 | 2.83 | 3.86 | 0.014 | 0.064 | 0.45 | 6.05 | 1.16 | 0.059 | 0.053 | 1.48 |

| | | | | | | | | | | | | | | | |
|---------|-----------|-----------|-----|------|----|------|------|-------|-------|------|------|------|-------|-------|------|
| SN20-22 | 61.052037 | 68.652663 | 1.1 | 4.41 | 12 | 0.66 | 1.92 | 0.005 | 0.031 | 0.27 | 3.15 | 0.57 | 0.030 | 0.028 | 0.86 |
| SN20-23 | 60.999156 | 68.900517 | 1.8 | 4.87 | 10 | 2.05 | 1.77 | 0.031 | 0.066 | 0.34 | 5.18 | 0.38 | 0.043 | 0.025 | 0.70 |
| SN20-24 | 61.138230 | 67.769780 | 3.2 | 4.53 | 10 | 4.25 | 1.91 | 0.012 | 0.055 | 0.22 | 4.85 | 0.74 | 0.046 | 0.045 | 0.50 |
| SN20-25 | 61.480500 | 66.831950 | 1.3 | 4.60 | 10 | 0.81 | 1.76 | 0.016 | 0.046 | 0.38 | 3.53 | 0.51 | 0.035 | 0.040 | 0.68 |
| SN20-26 | 61.828180 | 66.024740 | 0.8 | 4.65 | 9 | 0.66 | 1.57 | 0.007 | 0.034 | 0.46 | 3.25 | 0.42 | 0.027 | 0.020 | 0.69 |
| SN20-27 | 62.231080 | 65.458900 | 1.0 | 4.62 | 11 | 0.94 | 1.44 | 0.006 | 0.036 | 0.27 | 2.79 | 0.24 | 0.020 | 0.015 | 0.52 |
| SN20-28 | 62.735510 | 65.456760 | 0.5 | 4.53 | 9 | 0.30 | 0.69 | 0.003 | 0.031 | 0.19 | 1.92 | 0.22 | 0.015 | 0.011 | 0.43 |
| SN20-29 | 62.734590 | 65.419840 | 0.7 | 4.56 | 10 | 0.36 | 0.62 | 0.004 | 0.039 | 0.11 | 1.52 | 0.20 | 0.015 | 0.014 | 0.35 |
| SN20-30 | 63.154290 | 64.769320 | 0.9 | 4.50 | 8 | 0.38 | 0.80 | 0.004 | 0.020 | 0.12 | 1.95 | 0.30 | 0.020 | 0.015 | 0.51 |
| SN20-31 | 63.656070 | 64.724190 | 0.9 | 4.63 | 8 | 0.67 | 1.13 | 0.004 | 0.016 | 0.25 | 4.18 | 0.20 | 0.015 | 0.015 | 0.41 |
| SN20-32 | 64.184470 | 65.392610 | 0.6 | 4.51 | 7 | 0.31 | 0.49 | 0.002 | 0.012 | 0.09 | 1.35 | 0.19 | 0.013 | 0.010 | 0.31 |
| SN20-33 | 64.773900 | 65.146220 | 0.5 | 4.85 | 7 | 0.48 | 0.69 | 0.003 | 0.010 | 0.07 | 2.15 | 0.21 | 0.014 | 0.011 | 0.32 |
| SN20-34 | 65.292940 | 64.747451 | 0.7 | 4.52 | 8 | 0.52 | 0.63 | 0.003 | 0.040 | 0.08 | 4.54 | 0.20 | 0.015 | 0.017 | 0.39 |
| SN20-35 | 65.854647 | 65.027917 | 0.5 | 4.55 | 7 | 0.24 | 0.60 | 0.002 | 0.016 | 0.10 | 1.56 | 0.18 | 0.013 | 0.010 | 0.42 |
| SN20-36 | 66.400238 | 66.234517 | 0.7 | 4.61 | 6 | 1.53 | 1.50 | 0.007 | 0.025 | 0.07 | 1.92 | 0.16 | 0.010 | 0.007 | 0.23 |

Table S2. Spearman correlations $p < 0,05$

| | Distance to object of contami- nation | Latitude °N | Concentr ation mg/L | pH | SC | Mn | Fe | Co | Ni | Cu | Zn | As | Cd | Sb | Pb |
|--|--|----------------|---------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Distance to object of contami- nation | 1.00 | 0.48 | -0.68 | 0.24 | -0.54 | -0.64 | -0.51 | -0.52 | -0.60 | -0.23 | -0.50 | -0.22 | -0.51 | -0.42 | -0.28 |
| Latitude°N | 0.48 | 1.00 | -0.72 | 0.10 | -0.62 | -0.74 | -0.77 | -0.78 | -0.78 | -0.33 | -0.44 | -0.20 | -0.74 | -0.55 | -0.49 |
| Concentra- tion mg/L | -0.68 | -0.72 | 1.00 | -0.13 | 0.50 | 0.80 | 0.60 | 0.71 | 0.61 | 0.30 | 0.52 | 0.30 | 0.78 | 0.48 | 0.31 |
| pH | 0.24 | 0.10 | -0.13 | 1.00 | -0.01 | 0.04 | -0.13 | 0.10 | 0.04 | 0.08 | 0.02 | 0.02 | -0.12 | -0.02 | -0.24 |
| SC | -0.54 | -0.62 | 0.50 | -0.01 | 1.00 | 0.46 | 0.72 | 0.57 | 0.62 | 0.40 | 0.39 | 0.50 | 0.63 | 0.66 | 0.60 |
| Mn | -0.64 | -0.74 | 0.80 | 0.04 | 0.46 | 1.00 | 0.65 | 0.84 | 0.71 | 0.31 | 0.52 | 0.25 | 0.76 | 0.53 | 0.26 |
| Fe | -0.51 | -0.77 | 0.60 | -0.13 | 0.72 | 0.65 | 1.00 | 0.72 | 0.74 | 0.43 | 0.52 | 0.44 | 0.78 | 0.71 | 0.72 |
| Co | -0.52 | -0.78 | 0.71 | 0.10 | 0.57 | 0.84 | 0.72 | 1.00 | 0.84 | 0.50 | 0.51 | 0.40 | 0.81 | 0.70 | 0.50 |
| Ni | -0.60 | -0.78 | 0.61 | 0.04 | 0.62 | 0.71 | 0.74 | 0.84 | 1.00 | 0.42 | 0.62 | 0.30 | 0.70 | 0.65 | 0.50 |
| Cu | -0.23 | -0.33 | 0.30 | 0.08 | 0.40 | 0.31 | 0.43 | 0.50 | 0.42 | 1.00 | 0.59 | 0.43 | 0.54 | 0.60 | 0.66 |
| Zn | -0.50 | -0.44 | 0.52 | 0.02 | 0.39 | 0.52 | 0.52 | 0.51 | 0.62 | 0.59 | 1.00 | 0.27 | 0.56 | 0.58 | 0.51 |
| As | -0.22 | -0.20 | 0.30 | 0.02 | 0.50 | 0.25 | 0.44 | 0.40 | 0.30 | 0.43 | 0.27 | 1.00 | 0.53 | 0.68 | 0.58 |
| Cd | -0.51 | -0.74 | 0.78 | -0.12 | 0.63 | 0.76 | 0.78 | 0.81 | 0.70 | 0.54 | 0.56 | 0.53 | 1.00 | 0.84 | 0.65 |
| Sb | -0.42 | -0.55 | 0.48 | -0.02 | 0.66 | 0.53 | 0.71 | 0.70 | 0.65 | 0.60 | 0.58 | 0.68 | 0.84 | 1.00 | 0.70 |
| Pb | -0.28 | -0.49 | 0.31 | -0.24 | 0.60 | 0.26 | 0.72 | 0.50 | 0.50 | 0.66 | 0.51 | 0.58 | 0.65 | 0.70 | 1.00 |

Table S3. The distance between the sampling point and some nearest possible source of pollution.

| Sample name | Distance to potential object of pollution, km | Possible source of pollution |
|--------------------|--|-------------------------------------|
| SN20-1 (0.22) | 3 | Small village |
| SN20-2 (0.22) | 23 | Small village |
| SN20-3 (0.22) | 32 | Big city |
| SN20-4 (0.22) | 20 | Big city |
| SN20-5 (0.22) | 1 | Small village |
| SN20-6 (0.22) | 17 | Small village |
| SN20-7 (0.22) | 1.5 | Small village |
| SN20-8 (0.22) | 19 | Small village |
| SN20-9 (0.22) | 3 | Small village |
| SN20-10 (0.22) | 2.5 | Small village |
| SN20-11 (0.22) | 6 | Small village |
| SN20-13 (0.22) | 40 | Small village |
| SN20-14 (0.22) | 21 | Small village |
| SN20-15 (0.22) | 7.6 | Torch |
| SN20-16 (0.22) | 3.7 | Torch |
| SN20-17 (0.22) | 21 | Torch |
| SN20-18 (0.22) | 11 | Big city |
| SN20-19 (0.22) | 7.5 | Torch |
| SN20-21 (0.22) | 15.6 | Torch |
| SN20-22 (0.22) | 4.6 | Big city |
| SN20-23 (0.22) | 19 | Big city |
| SN20-26 (0.22) | 17 | Torch |
| SN20-27 (0.22) | 10 | Big city |
| SN20-28 (0.22) | 65 | Big city |
| SN20-29 (0.22) | 65 | Big city |
| SN20-30 (0.22) | 51 | Small town |
| SN20-31 (0.22) | 51 | Small town |
| SN20-32 (0.22) | 31 | Small town |
| SN20-33 (0.22) | 92 | Small town |
| SN20-34 (0.22) | 10 | Small village |
| SN20-35 (0.22) | 53 | Small village |
| SN20-36 (0.22) | 22 | Big city |

Table S4. Results of PCA treatment of all data

| | | |
|------------------------------|-------------|-------------|
| Eigenvalues: | 7.13 | 2.49 |
| | Factor 1 | Factor 2 |
| Distance to pollution source | -0.46 | -0.43 |
| Latitude | -0.75 | -0.52 |
| Longitude | 0.68 | 0.51 |
| mg/l | 0.91 | -0.07 |
| pH | 0.23 | -0.34 |
| SC | 0.38 | 0.70 |
| Mn | 0.92 | 0.06 |
| Fe | 0.34 | 0.78 |
| Co | 0.91 | 0.14 |
| Ni | 0.69 | 0.56 |
| Cu | 0.02 | 0.48 |
| Zn | 0.20 | 0.34 |
| As | -0.11 | 0.53 |
| Cd | 0.47 | 0.79 |
| Sb | 0.10 | 0.59 |
| Pb | -0.03 | 0.96 |
| Expl.Var | 4.84 | 4.79 |
| Prp.Totl | 0.30 | 0.30 |

Table S5. Mean (\pm SD) concentration ($\mu\text{g L}^{-1}$) of metals in river water and snow water in the three distinct parts of the Ob River main stem upstream and downstream of its confluence with Vasyugan and Irtysh.

| Element | Ob River (Tom–Vasyugan, n = 4) | Snow SN20-1–SN20-10 (n = 10) | Ob River (Vasyugan–Irtysh, n = 11) | Snow SN20-11–SN20-21 (n = 11) | Ob River (Irtysh–Salemal, n = 16) | Snow SN20-22–SN20-36 (n = 15) |
|---------|--------------------------------|------------------------------|------------------------------------|-------------------------------|-----------------------------------|-------------------------------|
| Mn | 2.0 \pm 1.48 | 3.0 \pm 2.0 | 18.0 \pm 49.0 | 1.4 \pm 0.8 | 4.5 \pm 0.5 | 0.9 \pm 1.0 |
| Fe | 59 \pm 62 | 5.3 \pm 2.9 | 440 \pm 475 | 3.0 \pm 1.3 | 664 \pm 58 | 1.2 \pm 0.5 |
| Co | 0.04 \pm 0.02 | 0.03 \pm 0.02 | 0.07 \pm 0.1 | 0.01 \pm 0.005 | 0.07 \pm 0.01 | 0.007 \pm 0.008 |
| Ni | 0.6 \pm 0.2 | 0.09 \pm 0.04 | 0.9 \pm 0.5 | 0.06 \pm 0.03 | 1.9 \pm 0.1 | 0.03 \pm 0.016 |
| Cu | 1.7 \pm 0.5 | 0.3 \pm 0.2 | 1.7 \pm 0.2 | 0.2 \pm 0.1 | 2.3 \pm 0.2 | 0.2 \pm 0.1 |
| Zn | 4.8 \pm 3.2 | 16 \pm 22 | 3.0 \pm 1.5 | 8.8 \pm 10 | 5.5 \pm 3.2 | 2.9 \pm 1.3 |
| As | 1.4 \pm 0.2 | 0.3 \pm 0.1 | 1.3 \pm 0.5 | 0.4 \pm 0.3 | 1.5 \pm 0.07 | 0.3 \pm 0.2 |
| Cd | 0.01 \pm 0.01 | 0.04 \pm 0.006 | 0.009 \pm 0.009 | 0.03 \pm 0.01 | 0.01 \pm 0.006 | 0.02 \pm 0.01 |
| Sb | 0.1 \pm 0.02 | 0.05 \pm 0.07 | 0.1 \pm 0.02 | 0.02 \pm 0.01 | 0.09 \pm 0.004 | 0.019 \pm 0.01 |
| Pb | 0.07 \pm 0.1 | 0.8 \pm 0.4 | 0.2 \pm 0.1 | 0.8 \pm 0.3 | 0.2 \pm 0.02 | 0.5 \pm 0.2 |