**Supplementary material**

Figure S1 Shepard Diagram for all cores



Figure S2 Variation in sand, silt, clay, organic carbon and carbonate content (%) in core profile. Vertical dashed lines show average values over entire core depth.

 









Figure S3 Variation of Ni, V, Cr, Zn, Cu, Co, Pb, Y, Rb, Zr, Ba and Sr. Vertical dashed lines show average values over entire core depth.













Figure S4 Variation of SiO2, CaO, Al2O3, Na2O, Fe2O3, K2O, MgO, MnO, P2O5 and TiO2 in core profiles. Vertical dashed lines show average values over entire core depth.











Figure S5 Variation of Ni, V, Cr, Zn, Cu, Co, Pb, Y, Rb, Zr, Ba and Sr normalized to Al2O3 (wt. %) in core profiles. Vertical dashed lines show average values over entire core depth.













Figure S6 Variation of Enrichment Factors (EFs) for Ni, V, Cr, Zn, Cu, Co, Pb, Y, Rb, Zr, Ba and Sr using the UCC as a background. Vertical dashed lines show EF=1.











Table S1 The quality controls for major and trace elements measurements.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Ref. Material** | **Element** | **Certified value** | **Average value** | **STD** | **Recovery (%)** | **Precision (%)** | **LOD** |
|  | **Rb** | 20 | 19 | 0.8 | 95 | 4.2 | 2 |
|  | **Sr** | 567 | 553 | 10.1 | 97.5 | 1.8 | 2 |
|  | **Ba** | 275 | 294 | 8.7 | 106.9 | 2.9 | 11 |
|  | **Y** | 28.6 | 25 | 1.5 | 87.4 | 6.0 | 2 |
|  | **Zr** | 225 | 234 | 7.6 | 104.0 | 3.2 | 0.5 |
|  | **Nb** | 18.7 | 18 | 0.5 | 96.2 | 2.7 | 1 |
|  | **V** | 178 | 193 | 7.8 | 108.4 | 4.0 | 5 |
|  | **Cr** | 347 | 372 | 67.4 | 107.2 | 18.1 | 3 |
|  | **Co** | 33.4 | 36 | 1.4 | 107.7 | 3.8 | 4 |
|  | **Ni** | 163 | 159 | 7.8 | 97.5 | 4.9 | 2 |
|  | **Cu** | 33.2 | 36 | 1.5 | 108.4 | 4.6 | 3 |
| **ILG** | **Zn** | 83.7 | 80 | 1.3 | 95.5 | 1.6 | 4 |
|  | **Th** | 3 | 4 | 1.8 | 133.3 | 45 | 2 |
|  | **Pb** | 4 | 5 | 1.3 | 125 | 26 | 2 |
|  | **SiO2** | 50.5 | 50.3 | 0.096 | 99.6 | 0.19 | 0.050 |
|  | **Al2O3** | 16.2 | 15.9 | 0.124 | 98.1 | 0.77 | 0.018 |
|  | **Fe2O3** | 9.53 | 10.1 | 0.074 | 105.8 | 0.77 | 0.006 |
|  | **MnO** | 0.14 | 0.15 | 0.002 | 107.1 | 1.30 | 0.004 |
|  | **Mgo** | 8.17 | 8.18 | 0.114 | 100.1 | 1.39 | 0.015 |
|  | **CaO** | 8.04 | 8.01 | 0.026 | 99.6 | 0.32 | 0.040 |
|  | **Na2O** | 3.86 | 3.79 | 0.037 | 98.1 | 0.97 | 0.030 |
|  | **K2O** | 1.15 | 1.09 | 0.011 | 94.7 | 1.00 | 0.050 |
|  | **TiO2** | 1.75 | 1.78 | 0.007 | 101.7 | 0.39 | 0.004 |
|  | **P2O3** | 0.54 | 0.50 | 0.020 | 92.5 | 4.00 | 0.004 |

Note: n=4, (n) number of measurements, (STD) Standard deviation, (LOD) Limit of detection for trace elements (mg kg-1) and major elements (%).

Table S2 Factor Analysis, including data for the four cores studied.

|  |  |  |  |
| --- | --- | --- | --- |
| **Factor 1** | | **Factor 2** | |
| **Terrigenous origin** | | **Biogenic origin** | |
| Sand | **-0.90** | Gravel | **-0.82** |
| Silt | **0.76** | Silt | **0.60** |
| Clay | **0.66** | Clay | **0.60** |
| TiO2 | **0.76** | O.C | **0.72** |
| Al2O3 | **0.81** | CO3 | **-0.83** |
| Fe2O3 | **0.91** | SiO2 | **0.97** |
| MnO | **0.76** | TiO2 | **0.61** |
| MgO | **0.87** | CaO | **-0.85** |
| Na2O | **0.78** | K2O | **0.72** |
| K2O | **0.67** | Sr | **-0.85** |
| P2O5 | **0.85** | Ba | **0.84** |
| Rb | **0.79** | Y | **0.64** |
| Y | **0.70** | Zr | **0.96** |
| Nb | **0.75** | Nb | **0.60** |
| V | **0.92** | Cr | **0.60** |
| Cr | **0.79** | Zn | **0.60** |
| Ni | **0.89** | Pb | **0.60** |
| Cu | **0.65** |  |  |
| Zn | **0.82** |  |  |
| Pb | **0.67** |  |  |
| **Exp. Var** | **13.93** |  | **11.55** |
| **Prop. Total** | **0.46** |  | **0.38** |

Note: n=42 (include all cores), α=0.05 and P< 0.05.

Table S3 Correlation matrix with all geochemical parameters analyzed in all cores

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Gravel | Sand | Silt | Clay | O.C. | CO3 | SiO2 | TiO2 | Al2O3 | Fe2O3 | MnO | MgO | CaO | Na2O | K2O | P2O5 | Rb | Sr | Ba | Y | Zr | Nb | Th | V | Cr | Co | Ni | Cu | Zn | Pb |
| Gravel | 1.00 | 0.47 | -0.82 | -0.78 | -0.55 | 0.86 | -0.88 | -0.72 | -0.76 | -0.61 | -0.23 | 0.04 | 0.89 | -0.71 | -0.85 | -0.44 | -0.77 | 0.88 | -0.79 | -0.74 | -0.77 | -0.70 | -0.65 | -0.58 | -0.74 | -0.44 | -0.59 | -0.13 | -0.74 | -0.71 |
| Sand |  | 1.00 | -0.86 | -0.82 | -0.33 | 0.67 | -0.41 | -0.86 | -0.90 | -0.93 | -0.64 | -0.68 | 0.69 | -0.83 | -0.81 | -0.78 | -0.90 | 0.69 | -0.26 | -0.82 | -0.40 | -0.85 | -0.58 | -0.91 | -0.87 | -0.15 | -0.89 | -0.51 | -0.89 | -0.75 |
| Silt |  |  | 1.00 | 0.85 | 0.50 | -0.88 | 0.72 | 0.93 | 0.96 | 0.92 | 0.56 | 0.41 | -0.91 | 0.93 | 0.95 | 0.75 | 0.97 | -0.91 | 0.62 | 0.92 | 0.67 | 0.92 | 0.69 | 0.89 | 0.95 | 0.33 | 0.88 | 0.44 | 0.95 | 0.86 |
| Clay |  |  |  | 1.00 | 0.47 | -0.79 | 0.69 | 0.83 | 0.90 | 0.80 | 0.39 | 0.36 | -0.83 | 0.75 | 0.90 | 0.62 | 0.90 | -0.82 | 0.46 | 0.81 | 0.60 | 0.79 | 0.69 | 0.78 | 0.84 | 0.31 | 0.79 | 0.26 | 0.87 | 0.75 |
| O.C. |  |  |  |  | 1.00 | -0.73 | 0.73 | 0.61 | 0.52 | 0.42 | 0.21 | -0.19 | -0.69 | 0.39 | 0.64 | 0.34 | 0.55 | -0.72 | 0.59 | 0.58 | 0.75 | 0.60 | 0.46 | 0.34 | 0.54 | 0.23 | 0.41 | -0.02 | 0.55 | 0.54 |
| CO3 |  |  |  |  |  | 1.00 | -0.91 | -0.92 | -0.89 | -0.79 | -0.37 | -0.07 | 0.99 | -0.82 | -0.96 | -0.59 | -0.90 | 0.98 | -0.75 | -0.90 | -0.89 | -0.91 | -0.68 | -0.70 | -0.88 | -0.48 | -0.73 | -0.29 | -0.89 | -0.86 |
| SiO2 |  |  |  |  |  |  | 1.00 | 0.72 | 0.69 | 0.51 | 0.09 | -0.29 | -0.93 | 0.61 | 0.83 | 0.30 | 0.71 | -0.92 | 0.83 | 0.73 | 0.96 | 0.70 | 0.54 | 0.42 | 0.68 | 0.58 | 0.47 | 0.04 | 0.67 | 0.70 |
| TiO2 |  |  |  |  |  |  |  | 1.00 | 0.97 | 0.95 | 0.56 | 0.40 | -0.91 | 0.88 | 0.96 | 0.78 | 0.97 | -0.91 | 0.56 | 0.93 | 0.71 | 0.97 | 0.68 | 0.87 | 0.95 | 0.31 | 0.87 | 0.43 | 0.98 | 0.89 |
| Al2O3 |  |  |  |  |  |  |  |  | 1.00 | 0.96 | 0.56 | 0.48 | -0.90 | 0.91 | 0.97 | 0.77 | 0.99 | -0.89 | 0.54 | 0.93 | 0.64 | 0.95 | 0.72 | 0.92 | 0.96 | 0.29 | 0.91 | 0.46 | 0.98 | 0.88 |
| Fe2O3 |  |  |  |  |  |  |  |  |  | 1.00 | 0.65 | 0.64 | -0.79 | 0.91 | 0.89 | 0.85 | 0.95 | -0.78 | 0.41 | 0.89 | 0.49 | 0.93 | 0.65 | 0.95 | 0.94 | 0.17 | 0.92 | 0.56 | 0.97 | 0.84 |
| MnO |  |  |  |  |  |  |  |  |  |  | 1.00 | 0.65 | -0.36 | 0.62 | 0.45 | 0.65 | 0.55 | -0.35 | 0.03 | 0.51 | 0.11 | 0.57 | 0.28 | 0.65 | 0.57 | -0.03 | 0.67 | 0.48 | 0.58 | 0.45 |
| MgO |  |  |  |  |  |  |  |  |  |  |  | 1.00 | -0.06 | 0.45 | 0.27 | 0.67 | 0.44 | -0.06 | -0.29 | 0.33 | -0.32 | 0.39 | 0.32 | 0.70 | 0.45 | -0.36 | 0.63 | 0.52 | 0.48 | 0.32 |
| CaO |  |  |  |  |  |  |  |  |  |  |  |  | 1.00 | -0.83 | -0.97 | -0.57 | -0.91 | 0.99 | -0.76 | -0.90 | -0.89 | -0.89 | -0.67 | -0.71 | -0.88 | -0.50 | -0.73 | -0.28 | -0.89 | -0.85 |
| Na2O |  |  |  |  |  |  |  |  |  |  |  |  |  | 1.00 | 0.87 | 0.74 | 0.91 | -0.82 | 0.57 | 0.90 | 0.58 | 0.87 | 0.61 | 0.85 | 0.92 | 0.35 | 0.84 | 0.56 | 0.90 | 0.79 |
| K2O |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 1.00 | 0.68 | 0.97 | -0.96 | 0.66 | 0.93 | 0.78 | 0.94 | 0.72 | 0.82 | 0.94 | 0.38 | 0.83 | 0.34 | 0.96 | 0.89 |
| P2O5 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 1.00 | 0.77 | -0.59 | 0.30 | 0.70 | 0.31 | 0.78 | 0.56 | 0.82 | 0.79 | 0.01 | 0.80 | 0.46 | 0.80 | 0.68 |
| Rb |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 1.00 | -0.92 | 0.58 | 0.95 | 0.68 | 0.96 | 0.73 | 0.91 | 0.97 | 0.31 | 0.90 | 0.43 | 0.99 | 0.90 |
| Sr |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 1.00 | -0.80 | -0.90 | -0.89 | -0.90 | -0.68 | -0.72 | -0.89 | -0.48 | -0.74 | -0.27 | -0.89 | -0.87 |
| Ba |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 1.00 | 0.62 | 0.80 | 0.58 | 0.44 | 0.38 | 0.61 | 0.44 | 0.42 | 0.13 | 0.56 | 0.62 |
| Y |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 1.00 | 0.73 | 0.93 | 0.66 | 0.84 | 0.93 | 0.43 | 0.81 | 0.41 | 0.93 | 0.87 |
| Zr |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 1.00 | 0.71 | 0.48 | 0.39 | 0.65 | 0.70 | 0.42 | 0.04 | 0.64 | 0.69 |
| Nb |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 1.00 | 0.68 | 0.85 | 0.93 | 0.34 | 0.84 | 0.41 | 0.96 | 0.88 |
| Th |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 1.00 | 0.66 | 0.71 | 0.15 | 0.67 | 0.17 | 0.70 | 0.72 |
| V |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 1.00 | 0.91 | 0.10 | 0.92 | 0.58 | 0.93 | 0.83 |
| Cr |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 1.00 | 0.31 | 0.91 | 0.46 | 0.97 | 0.88 |
| Co |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 1.00 | 0.08 | -0.12 | 0.25 | 0.30 |
| Ni |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 1.00 | 0.53 | 0.91 | 0.79 |
| Cu |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 1.00 | 0.48 | 0.43 |
| Zn |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 1.00 | 0.89 |
| Pb |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 1.00 |

Note: n= 42, α=0.05 and P< 0.05.