## Fig. S1 Sample locations in each geological formation and near the HTP and HYA mining areas in this study. Deposits are also shown in this map (after Zhang et al., 2020b).



## Table S1 Analytical methods, lower detection limits and digestion methods for analysis indictors.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sample | Analysis Indicator | Analytical method | Digestion methods | Detection limits | Unit | CRMs |
| Rock/Ore | Soil |
| Rock/ore and soil | Al2O3 | XRF | Li2B4O7 glass flux shee | 0.03 | % | GSR-1, GSR-2, GSR-3, GSR-5, GSR-6 | GSS-1, GSS-2, GSS-3, GSS-8 |
| Rock/ore and soil | CaO | XRF | Li2B4O7 glass flux shee | 0.02 | % | GSR-1, GSR-2, GSR-3, GSR-5, GSR-6 | GSS-1, GSS-2, GSS-3, GSS-8 |
| Rock/ore and soil | TFe2O3 | XRF | Li2B4O7 glass flux shee | 0.02 | % | GSR-1, GSR-2, GSR-3, GSR-5, GSR-6 | GSS-1, GSS-2, GSS-3, GSS-8 |
| Rock/ore and soil | K2O | XRF | Li2B4O7 glass flux shee | 0.03 | % | GSR-1, GSR-2, GSR-3, GSR-5, GSR-6 | GSS-1, GSS-2, GSS-3, GSS-8 |
| Rock/ore and soil | Na2O | XRF | Li2B4O7 glass flux shee | 0.02 | % | GSR-1, GSR-2, GSR-3, GSR-5, GSR-6 | GSS-1, GSS-2, GSS-3, GSS-8 |
| Rock/ore and soil | MgO | XRF | Li2B4O7 glass flux shee | 0.02 | % | GSR-1, GSR-2, GSR-3, GSR-5, GSR-6 | GSS-1, GSS-2, GSS-3, GSS-8 |
| Rock/ore and soil | SiO2 | XRF | Li2B4O7 glass flux shee | 0.05 | % | GSR-1, GSR-2, GSR-3, GSR-5, GSR-6 | GSS-1, GSS-2, GSS-3, GSS-8 |
| Rock/ore and soil | La | ICP-MS |  HF, HCl, HNO₃, HClO4 | 0.1 | μg/g | GSR-1, GSR-2, GSR-3, GSR-6 | GSS-30, GSS-33, GSS-34, GSS-35 |
| Rock/ore and soil | Ce | ICP-MS |  HF, HCl, HNO₃, HClO4 | 0.2 | μg/g | GSR-1, GSR-2, GSR-3, GSR-6 | GSS-30, GSS-33, GSS-34, GSS-35 |
| Rock/ore and soil | Pr | ICP-MS |  HF, HCl, HNO₃, HClO4 | 0.1 | μg/g | GSR-1, GSR-2, GSR-3, GSR-6 | GSS-30, GSS-33, GSS-34, GSS-35 |
| Rock/ore and soil | Nd | ICP-MS |  HF, HCl, HNO₃, HClO4 | 0.1 | μg/g | GSR-1, GSR-2, GSR-3, GSR-6 | GSS-30, GSS-33, GSS-34, GSS-35 |
| Rock/ore and soil | Sm | ICP-MS |  HF, HCl, HNO₃, HClO4 | 0.05 | μg/g | GSR-1, GSR-2, GSR-3, GSR-6 | GSS-30, GSS-33, GSS-34, GSS-35 |
| Rock/ore and soil | Eu | ICP-MS |  HF, HCl, HNO₃, HClO4 | 0.03 | μg/g | GSR-1, GSR-2, GSR-3, GSR-6 | GSS-30, GSS-33, GSS-34, GSS-35 |
| Rock/ore and soil | Cd | ICP-MS |  HF, HCl, HNO₃, HClO4 | 0.1 | μg/g | GSR-1, GSR-2, GSR-3, GSR-6 | GSS-30, GSS-33, GSS-34, GSS-35 |
| Rock/ore and soil | Tb | ICP-MS |  HF, HCl, HNO₃, HClO4 | 0.05 | μg/g | GSR-1, GSR-2, GSR-3, GSR-6 | GSS-30, GSS-33, GSS-34, GSS-35 |
| Rock/ore and soil | Dy | ICP-MS |  HF, HCl, HNO₃, HClO4 | 0.05 | μg/g | GSR-1, GSR-2, GSR-3, GSR-6 | GSS-30, GSS-33, GSS-34, GSS-35 |
| Rock/ore and soil | Ho | ICP-MS |  HF, HCl, HNO₃, HClO4 | 0.01 | μg/g | GSR-1, GSR-2, GSR-3, GSR-6 | GSS-30, GSS-33, GSS-34, GSS-35 |
| Rock/ore and soil | Er | ICP-MS |  HF, HCl, HNO₃, HClO4 | 0.05 | μg/g | GSR-1, GSR-2, GSR-3, GSR-6 | GSS-30, GSS-33, GSS-34, GSS-35 |
| Rock/ore and soil | Tm | ICP-MS |  HF, HCl, HNO₃, HClO4 | 0.02 | μg/g | GSR-1, GSR-2, GSR-3, GSR-6 | GSS-30, GSS-33, GSS-34, GSS-35 |
| Rock/ore and soil | Yb | ICP-MS |  HF, HCl, HNO₃, HClO4 | 0.05 | μg/g | GSR-1, GSR-2, GSR-3, GSR-6 | GSS-30, GSS-33, GSS-34, GSS-35 |
| Rock/ore and soil | Lu | ICP-MS |  HF, HCl, HNO₃, HClO4 | 0.01 | μg/g | GSR-1, GSR-2, GSR-3, GSR-6 | GSS-30, GSS-33, GSS-34, GSS-35 |
| Rock/ore and soil | Y | ICP-MS |  HF, HCl, HNO₃, HClO4 | 0.5 | μg/g | GSR-1, GSR-2, GSR-3, GSR-6 | GSS-30, GSS-33, GSS-34, GSS-35 |
| Soil | C.org | VOL | K2Cr2O7,H₂SO₄ | 0.02 | μg/g | - | GSS-21, GBW07431, GBW07435, GBW07432 |
| Soil | pH | ISE | Water | 0.01 | - | - | GBW07412~GBW07417 |

CRMs: Certified reference materials.

## Table S2 Allowance of accuracy and precision for routine analysis.

|  |  |  |
| --- | --- | --- |
| Concentration range | Accuracy | Precision |
|  |   |  |
| ＜3 detection limit | ≤0.17 | ≤50% |
| ＞3 detection limit | ≤0.15 |
| 1-5% | ≤0.10 |
| ＞5% | ≤0.15 |

CRMs: Certified reference materials; , the average determined value of CRMi; Ci, the determined value of CRMi; Cs, the recommended value of CRMi.; C1: the first determined value; C2: the re-determined value.