STANDARD SOIL REFERENCE MATERIAL FOR Au-REE DEPOSITS

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UpDeep_MIN_B3

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This activity has received funding from the European Institute of Innovation and Technology (EIT), a body of the European Union, under the Horizon 2020, the EU Framework Programme for Research and Innovation

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1. INTRODUCTION

UpDeep standard reference materials (SRM) are intended to be used in weak leach (i.e. geochemical) analysis for providing an affordable method of controlling the quality of soil samples for mineral exploration purposes. SRMs are produced less rigorously compared to e.g certified reference materials. The UpDeep SRM samples do not follow the ISO standardization and are therefore not certified reference materials (CRM). However, the UpDeep standard reference materials are more affordable and can thus be inserted in the analysis sequence more frequently than CRMs. For the user of the UpDeep SRMs, the purpose is to quantify laboratory accuracy externally in the form of bias.

2. SOURCE MATERIALS

UpDeep_MIN_B3 is mineral soil material collected from B-horizon on the Au-REE bearing quartz-hematite vein in the Mäkärä exploration target, northern Finland, in 2017.

UpDeep_MIN_B3 is one of six reference materials (Ah- and B-horizon, common juniper foliage, Scots pine bark, Norway spruce bark and foliage) collected from the Mäkärä exploration target in the UpDeep project.

3. COMMINUTION AND HOMOGENISATION PROCEDURES

The UpDeep_MIN_B3 SRM was prepared as follows:

- sampling of the bulk B horizon sample in the field
- splitting the bulk sample in the field
- drying at 40°C for a day
- breaking down of lumps by hands and homogenization
- sieving - 180 µm in the laboratory

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- homogenization and splitting the material into subsamples (á 50 g) using a splitting device and a sample divider (Retsch PT 100)

4. ANALYTICAL PROGRAM

UpDeep_MIN_B3 SRM samples were analyzed in one geochemical laboratory (ALS Minerals/ALS Global (Vancouver, Canada through, ALS Sodankylä, Finland). The methods used were:

- super trace modified weak aqua regia by ICP-MS with REE add-on (method code ME-MS41WREE)
- Sodium pyrophosphate leach with ICP-MS (method code ME-MS07)
- Leach pH
- LOI 500 for XRF (WST-SEQ)

Ten UpDeep_MIN_B3 SRM aliquots were sent to the laboratory. Tables 1 and 2 (Chapter 6) present information values for the laboratory results. The RSD% values < 5 are marked as green, the 5≤RSD%≥15 are marked with orange and the RSD%>15 are marked with red. Elements having less than four observations between the detection limits are coloured gray.

5. STATISTICAL ANALYSIS

Analysed elements, units, lower (LDL) and upper detection limits (UDL), percentage of <LDL, >UDL and discretized values, mean, median, standard deviation (SD), relative standard deviation (RSD%) and median absolute deviation (MAD) are presented in Chapter 6.

Original data, quality control monitoring and statistical measures are available upon request.

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6. PARTICIPANT LABORATORIES

ALS, Vancouver, Canada

Table 1. Statistics for UpDeep_MIN_B3 analysed with super trace modified weak aqua regia method by ICP-MS with REE add-on (method code ME-MS41W-REE), based on ten aliquots. LDL = lower detection limit, pct_LDL = percent of samples under lower detection limit, UDL = upper detection limit, pct_UDL = percent of samples over upper detection limit, pct_discr = percent of discretized values, SD = standard deviation, RSD% = relative standard deviation percent and MAD= median absolute deviation. The RSD% values < 5 are marked as green, the 5≤RSD%≥15 are marked with orange and the RSD%>15 are marked with red. Elements having less than four observations between the detection limits are coloured gray.

Element	unit	LDL	pct_LDL	UDL	pct_UDL	pct_discr	MEAN	MEDIAN	SD	RSD %	MAD
Ag	ppm	NA	0	NA	0	0	0.2723	0.1575	0.3105	114.0432	0.1401
Al	%	NA	0	NA	0	30	0.901	0.895	0.0238	2.6394	0.0148
As	ppm	NA	0	NA	0	0	0.968	0.7	0.8539	88.2132	0.1483
Au	ppm	NA	0	NA	0	0	0.0231	0.0026	0.0592	256.1938	0.0023
B	ppm	10	100	NA	0	100	7.5	7.5	0	NA	0
Ba	ppm	NA	0	NA	0	0	15.35	15.3	0.4275	2.7852	0.4448
Be	ppm	NA	0	NA	0	30	0.188	0.185	0.0148	7.8496	0.0148
Bi	ppm	NA	0	NA	0	0	0.055	0.053	0.0063	11.5311	0.0044
Ca	%	NA	0	NA	0	100	0.03	0.03	0	NA	0
Cd	ppm	NA	0	NA	0	0	0.0203	0.02	0.0033	16.2636	0.003
Ce	ppm	NA	0	NA	0	0	9.109	9.02	0.5942	6.523	0.6523
Co	ppm	NA	0	NA	0	0	3.545	3.495	0.226	6.3763	0.252
Cr	ppm	NA	0	NA	0	0	31.02	30.85	1.3863	4.469	1.0378
Cs	ppm	NA	0	NA	0	0	0.3575	0.3545	0.0181	5.0492	0.0119
Cu	ppm	NA	0	NA	0	0	25.55	24.25	2.9129	11.4008	1.6309
Dy	ppm	NA	0	NA	0	0	0.6536	0.6335	0.0477	7.3003	0.0185
Er	ppm	NA	0	NA	0	0	0.3303	0.323	0.022	6.6699	0.0104
Eu	ppm	NA	0	NA	0	0	0.1571	0.153	0.0131	8.3451	0.0059
Fe	%	NA	0	NA	0	0	2.355	2.345	0.0493	2.0922	0.0371
Ga	ppm	NA	0	NA	0	0	6.911	6.92	0.3784	5.4758	0.2669
Gd	ppm	NA	0	NA	0	0	0.7558	0.739	0.055	7.2758	0.0385

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Ge	ppm	NA	0	NA	0	0	0.0368	0.037	0.0032	8.574	0.0037
Hf	ppm	NA	0	NA	0	30	0.0474	0.0475	0.0016	3.4737	0.0022
Hg	ppm	NA	0	NA	0	40	0.021	0.0215	0.0021	10.039	0.0022
Ho	ppm	NA	0	NA	0	30	0.1111	0.1075	0.0093	8.3304	0.0052
In	ppm	NA	0	NA	0	30	0.0316	0.03	0.0042	13.2761	0.0015
K	%	NA	0	NA	0	100	0.02	0.02	0	NA	0
La	ppm	NA	0	NA	0	0	5.086	4.99	0.3301	6.4908	0.3558
Li	ppm	NA	0	NA	0	30	1.96	1.95	0.143	7.2951	0.2224
Lu	ppm	NA	0	NA	0	30	0.0387	0.038	0.0028	7.2115	0.003
Mg	%	NA	0	NA	0	90	0.091	0.09	0.0032	3.475	0
Mn	ppm	NA	0	NA	0	0	96.45	95.85	3.2202	3.3387	1.7791
Mo	ppm	NA	0	NA	0	70	0.211	0.21	0.0099	4.7129	0.0148
Na	%	0.001	50	NA	0	80	0.0012	0.0009	0.0007	63.4742	0.0002
Nb	ppm	NA	0	NA	0	0	1.758	1.715	0.0846	4.814	0.0519
Nd	ppm	NA	0	NA	0	0	5.047	4.95	0.3693	7.3177	0.3929
Ni	ppm	NA	0	NA	0	0	12.13	11.825	1.4463	11.9233	0.4448
P	%	NA	0	NA	0	80	0.0227	0.0225	0.0008	3.6268	0.0007
Pb	ppm	NA	0	NA	0	0	20.28	19.925	3.5825	17.6654	4.5961
Pd	ppm	0.001	60	NA	0	90	0.0022	0.0008	0.0045	199.1753	0
Pr	ppm	NA	0	NA	0	0	1.274	1.24	0.0876	6.8798	0.0927
Pt	ppm	0.002	50	NA	0	100	0.0018	0.0018	0.0003	15.0585	0.0004
Rb	ppm	NA	0	NA	0	0	5.432	5.4	0.2324	4.2778	0.252
Re	ppm	0.001	100	NA	0	100	0.0008	0.0008	0	NA	0
S	%	NA	0	NA	0	100	0.01	0.01	0	NA	0
Sb	ppm	NA	0	NA	0	0	0.1655	0.127	0.1608	97.1302	0.0259
Sc	ppm	NA	0	NA	0	0	1.6945	1.685	0.0797	4.7015	0.063
Se	ppm	NA	0	NA	0	80	0.32	0.3	0.0422	13.1762	0
Sm	ppm	NA	0	NA	0	0	0.8863	0.868	0.0622	7.0214	0.0297
Sn	ppm	NA	0	NA	0	0	1.642	1.565	0.1843	11.2216	0.1927
Sr	ppm	NA	0	NA	0	0	1.425	1.425	0.07	4.9095	0.0593
Ta	ppm	0.005	70	NA	0	100	0.0041	0.0038	0.0006	14.6378	0
Tb	ppm	NA	0	NA	0	0	0.1048	0.1025	0.0074	7.0522	0.0037
Te	ppm	NA	0	NA	0	70	0.052	0.05	0.014	26.8925	0.0148
Th	ppm	NA	0	NA	0	0	1.6075	1.57	0.1728	10.7481	0.1112
Ti	%	NA	0	NA	0	0	0.0839	0.0835	0.0027	3.2007	0.003
Tl	ppm	NA	0	NA	0	0	0.038	0.0375	0.0022	5.8186	0.0022
Tm	ppm	NA	0	NA	0	40	0.0442	0.043	0.0025	5.7236	0.0015

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U	ppm	NA	0	NA	0	0	0.3756	0.376	0.0155	4.1383	0.017
V	ppm	NA	0	NA	0	0	55.21	54.95	2.9156	5.281	2.5946
W	ppm	NA	0	NA	0	30	0.0258	0.026	0.0021	8.1303	0.003
Y	ppm	NA	0	NA	0	0	2.865	2.785	0.1923	6.7124	0.0815
Yb	ppm	NA	0	NA	0	0	0.2797	0.2725	0.0213	7.618	0.003
Zn	ppm	NA	0	NA	0	0	19.22	19.1	0.9259	4.8175	0.8896
Zr	ppm	NA	0	NA	0	0	2.242	2.24	0.1127	5.0278	0.0741

Table 2. Statistics for UpDeep_MIN_B3 analysed with sodium pyrophosphate leach method by ICP-MS (method code ME-MS07), based on ten aliquots. LDL = lower detection limit, pct_LDL = percent of samples under lower detection limit, UDL = upper detection limit, pct_UDL = percent of samples over upper detection limit, pct_discr = percent of discretized values, SD = standard deviation, RSD% = relative standard deviation percent and MAD= median absolute deviation. The RSD% values < 5 are marked as green, the 5≤RSD%≥15 are marked with orange and the RSD%>15 are marked with red. Elements having less than four observations between the detection limits are coloured gray.

Element	unit	LDL	pct_LDL	UDL	pct_UDL	pct_discr	MEAN	MEDIAN	SD	RSD %	MAD
Ag	ppm	NA	0	NA	0	40	0.0071	0.007	0.0016	22.4666	0.0015
Al	ppm	NA	0	NA	0	0	5237	5260	82.6035	1.5773	96.369
As	ppm	NA	0	NA	0	0	0.305	0.305	0.0453	14.8449	0.0519
Au	ppm	0.001	60	NA	0	100	0.0008	0.0008	0.0001	15.1882	0
B	ppm	NA	0	NA	0	30	0.86	0.8	0.2675	31.1045	0.1483
Ba	ppm	NA	0	NA	0	0	5.72	5.755	0.1196	2.0914	0.0593
Be	ppm	NA	0	NA	0	0	0.0817	0.078	0.0105	12.8897	0.0044
Bi	ppm	NA	0	NA	0	30	0.0139	0.014	0.0016	11.4758	0.0022
Br	ppm	NA	0	NA	0	100	3.7	4	0.483	13.0553	0
Ca	ppm	NA	0	NA	0	80	33	30	6.7495	20.453	0
Cd	ppm	NA	0	NA	0	40	0.0052	0.005	0.0024	46.9308	0.0022
Ce	ppm	NA	0	NA	0	0	1.6915	1.68	0.0371	2.1946	0.0297
Co	ppm	NA	0	NA	0	30	0.6191	0.6215	0.0183	2.9622	0.0267
Cr	ppm	NA	0	NA	0	0	11.255	11.3	0.1624	1.4426	0.1483
Cs	ppm	NA	0	NA	0	0	0.0768	0.0766	0.0087	11.3955	0.0092
Cu	ppm	NA	0	NA	0	0	3.554	3.56	0.0677	1.9047	0.0741
Dy	ppm	NA	0	NA	0	0	0.2233	0.2255	0.0111	4.987	0.0111
Er	ppm	NA	0	NA	0	0	0.1097	0.109	0.0067	6.1082	0.0037

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Eu	ppm	NA	0	NA	0	0	0.0463	0.047	0.0032	6.8859	0.004
Fe	ppm	NA	0	NA	0	0	6850	6850	98.3192	1.4353	103.782
Ga	ppm	NA	0	NA	0	0	2.067	2.055	0.0512	2.4779	0.0222
Gd	ppm	NA	0	NA	0	0	0.2211	0.222	0.01	4.5451	0.0089
Ge	ppm	NA	0	NA	0	0	0.0728	0.073	0.0058	8.0043	0.0037
Hf	ppm	NA	0	NA	0	0	0.1044	0.1022	0.0098	9.4147	0.0124
Hg	ppm	0.01	30	NA	0	90	0.0102	0.01	0.0036	35.3448	0
Ho	ppm	NA	0	NA	0	0	0.0401	0.0405	0.0021	5.1153	0.0013
I	ppm	NA	0	NA	0	0	2.993	2.975	0.1251	4.1792	0.1112
In	ppm	NA	0	NA	0	40	0.0076	0.007	0.0023	29.8761	0.0022
K	ppm	NA	0	NA	0	40	108.7	108	1.6364	1.5054	1.4826
La	ppm	NA	0	NA	0	0	1.067	1.06	0.029	2.7163	0.0185
Li	ppm	NA	0	NA	0	40	0.37	0.365	0.0194	5.2531	0.0074
Lu	ppm	NA	0	NA	0	0	0.0131	0.0129	0.0015	11.7264	0.0018
Mg	ppm	NA	0	NA	0	0	104.8	104.75	2.2632	2.1596	2.2239
Mn	ppm	NA	0	NA	0	0	17.475	17.4	0.2908	1.6643	0.3706
Mo	ppm	NA	0	NA	0	0	0.0711	0.0705	0.0055	7.8014	0.0044
Nb	ppm	NA	0	NA	0	0	1.092	1.0925	0.0261	2.386	0.0259
Nd	ppm	NA	0	NA	0	0	1.0163	1.0125	0.0261	2.5676	0.0311
Ni	ppm	NA	0	NA	0	0	2.023	2.045	0.0718	3.5497	0.0964
Pb	ppm	NA	0	NA	0	0	1.929	1.915	0.1535	7.959	0.1742
Pr	ppm	NA	0	NA	0	0	0.2686	0.268	0.0119	4.4337	0.0119
Rb	ppm	NA	0	NA	0	0	1.3375	1.3475	0.0763	5.7056	0.0927
Re	ppm	0.0002	60	NA	0	60	0.0002	0.0001	0.0001	55.3767	0
Sb	ppm	NA	0	NA	0	0	0.0528	0.054	0.0054	10.135	0.0036
Se	ppm	NA	0	NA	0	0	0.191	0.21	0.0765	40.0599	0.089
Sm	ppm	NA	0	NA	0	0	0.2417	0.244	0.0188	7.7796	0.017
Sn	ppm	NA	0	NA	0	0	0.3398	0.3425	0.0143	4.2166	0.0082
Sr	ppm	NA	0	NA	0	0	0.4179	0.4175	0.0338	8.0939	0.0348
Ta	ppm	NA	0	NA	0	30	0.0491	0.0495	0.003	6.1812	0.0022
Tb	ppm	NA	0	NA	0	0	0.0368	0.0363	0.0044	12.0307	0.0048
Te	ppm	0.005	100	NA	0	100	0.0038	0.0038	0	NA	0
Th	ppm	NA	0	NA	0	0	0.6781	0.684	0.0225	3.3161	0.0178
Ti	ppm	NA	0	NA	0	0	487.5	484.5	9.8911	2.0289	10.3782
Tl	ppm	NA	0	NA	0	0	0.0107	0.0105	0.0028	25.708	0.0037
Tm	ppm	NA	0	NA	0	0	0.0179	0.0183	0.0016	8.7632	0.001
U	ppm	NA	0	NA	0	0	0.115	0.1155	0.0037	3.2536	0.0037

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V	ppm	NA	0	NA	0	0	14.14	14.075	0.3195	2.2599	0.3336
W	ppm	NA	0	NA	0	30	0.0442	0.043	0.0043	9.646	0.0037
Y	ppm	NA	0	NA	0	0	0.9496	0.9475	0.0371	3.9061	0.0222
Yb	ppm	NA	0	NA	0	30	0.1166	0.1155	0.0049	4.2441	0.0067
Zn	ppm	NA	0	NA	0	0	3.745	3.75	0.091	2.4286	0.1112
Zr	ppm	NA	0	NA	0	0	2.863	2.87	0.0577	2.0169	0.0371

7. PREPARER ANS SUPPLIER

UpDeep_MIN_B3 SRMs are prepared by the Geological Survey of Finland (GTK) in a project Upscaling deep buried geochemical exploration techniques into European business (UpDeep) and supplied by GTK and Scandinavian Geopool.

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8. INTENDED USE

UpDeep_MIN_B3 SRMs are intended to quantify laboratory accuracy and to monitor laboratory precision, drift, periodic concentration shifts, unusual breaks and outliers in analytical results of soil B horizon samples for mineral exploration.

9. STABILITY AND STORAGE INSTRUCTIONS

UpDeep_MIN_B3 SRM should be stored in a room temperature unopened in their own plastic containers. Stability of the materials are not tested.

10. INSTRUCTIONS FOR CORRECT USE

UpDeep_MIN_B3 SRM is a dry sample, but needs to be sieved to a requisite size prior to analysis. It should be only used with samples of same matrix and concentration ranges.

11. HANDLING INSTRUCTIONS

Keep dry and do not touch with bare hands to avoid SRM contamination.

12. TRACEABILITY

The analyzed SRM samples represent the entire batch of prepared SRM. All the analyzed samples have individual names and can be traced back into the original analytical results. The laboratory was chosen on the basis the availability of the analytical services specific to soils and offered range of elements usable for mineral exploration. The laboratories have ISO/IEC 17025:2005 accreditation.

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13. LEGAL NOTICE

Geological Survey of Finland and Scandinavian Geopool have prepared and Geological Survey of Finland and Vienna Technical University have statistically evaluated the property values of this reference material to the best of their ability. Geological Survey of Finland, Scandinavian Geopool and Vienna Technical University assume no liability for any errors in this material and information. Geological Survey of Finland, Scandinavian Geopool and Vienna Technical University shall be free from, and indemnified by the user against, any liability for any damage or loss, whether direct or consequential, arising from or as a result of the use of this material and information.

14. REFERENCES

Reimann, C., Filzmoser, P., Garrett, R. & Dutter, R. 2008. Statistical data analysis explained: applied environmental statistics with R. John Wiley & Sons Ltd, England. 343 p.

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