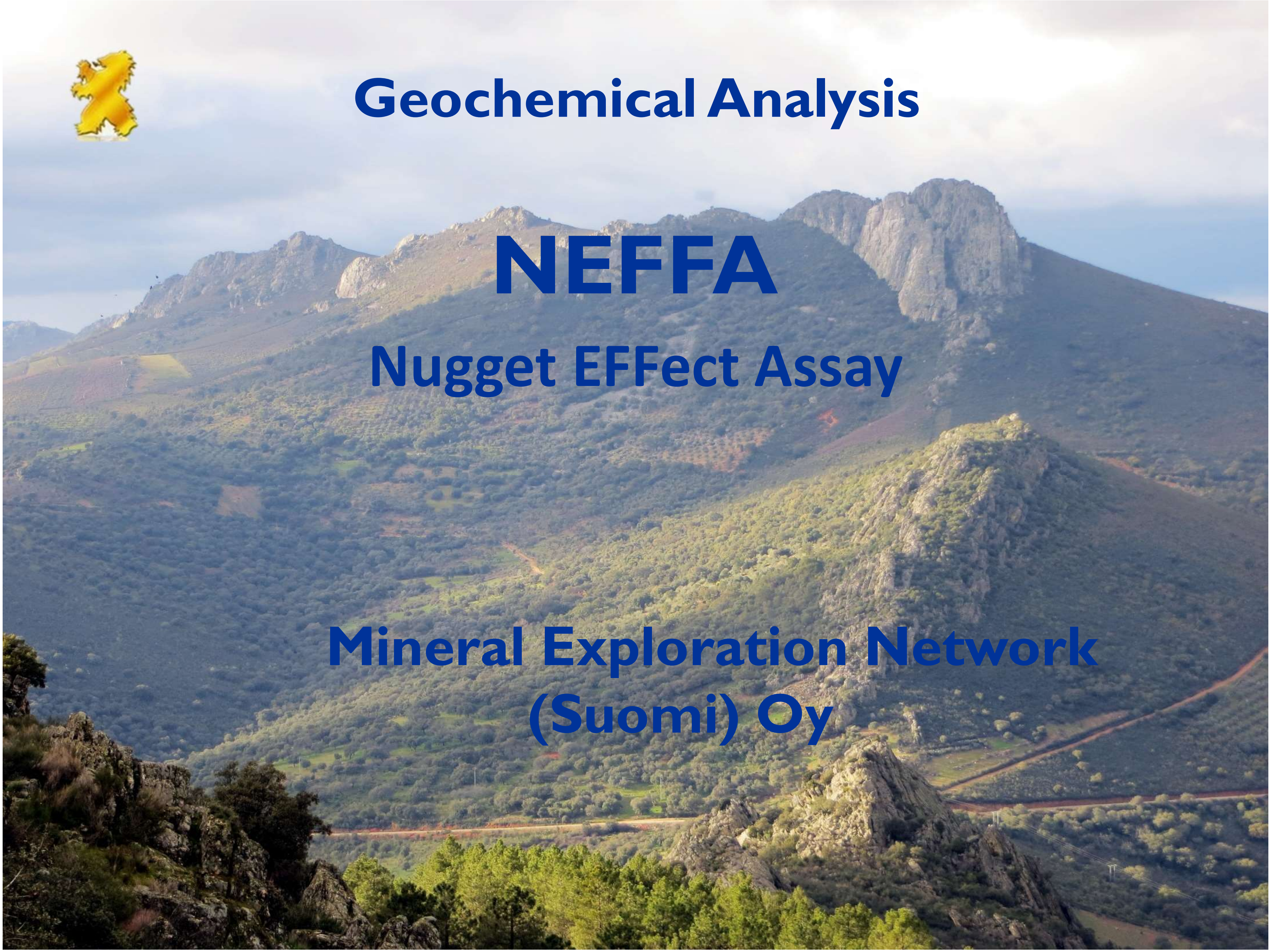
Geochemical Analysis

NEFFA

Nugget EFFect Assay

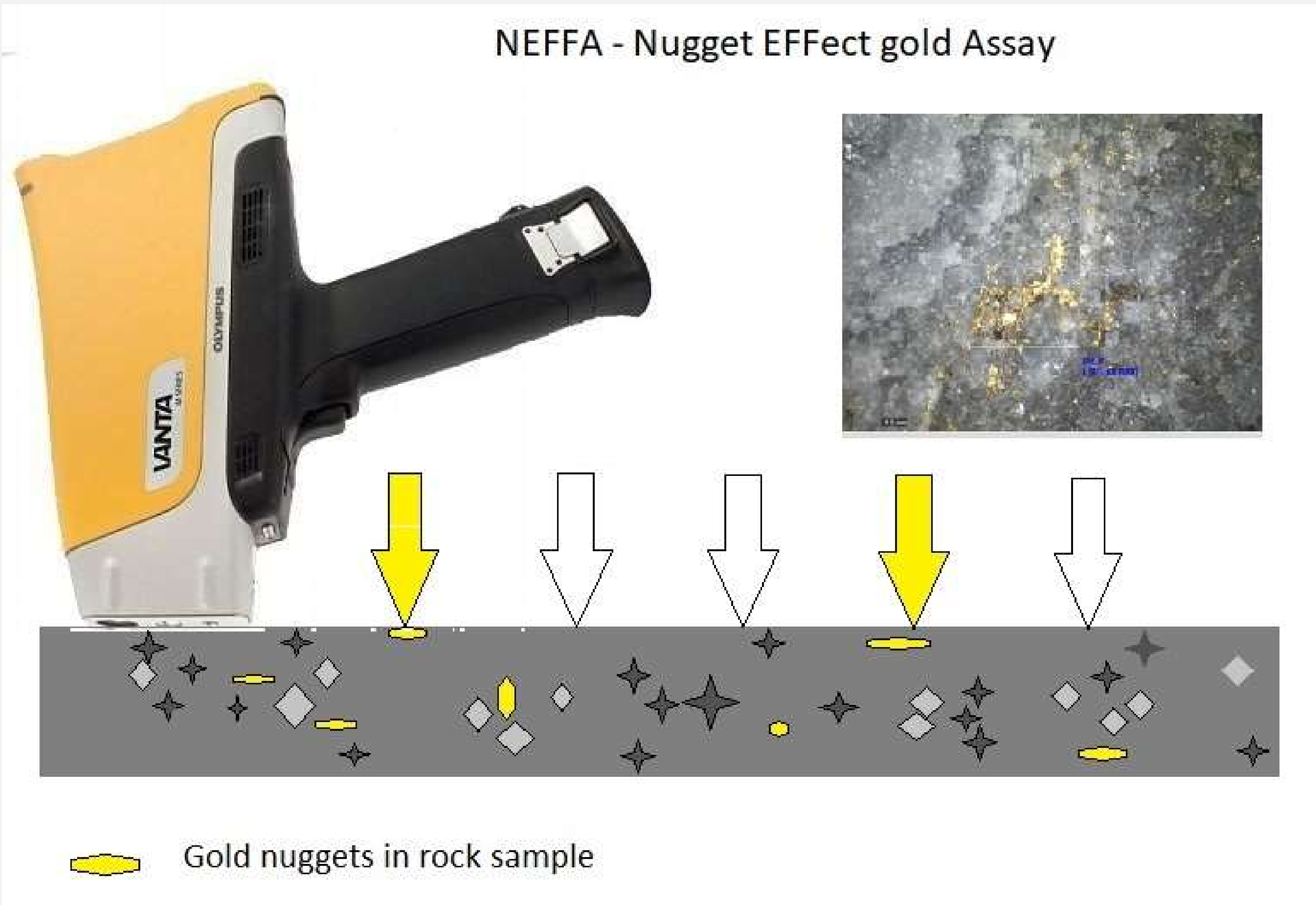
Mineral Exploration Network (Suomi) Oy



Nugget EFFect Gold Assay

- Nugget EFFect gold Analysis (NEFFA) is an original analytical methodology designed to reduce the cost of geochemical analysis and make geochemical exploration programs more efficient.
- The utilisation of the 'nugget-effect' to detect the presence of gold in geological samples
- The application of non-destructive, multiple, systematic analyses of geological samples, utilising a 'matrix' based system.
- Based upon an adaptation of traditional analytical procedures, principally X-Ray Fluorescence (XRF), and applied to a new analytical technique and methodology.
- Redefining the sample preparation procedure, reducing the need for excessive sample preparation; no chemical agents or destruction of samples during preparation procedure.

Nugget EFFect Gold Assay



Traditional Au Assay Analysis

- The nugget effect occurs when there are anomalously high precious metal assays resulting from the analysis of samples that may not adequately represent the composition of the bulk material tested.
- Nugget effect is problematic for reserve/resource evaluation.
- Traditional methods of Au assay require sophisticated and expensive analytical procedures (ICP-MS, ICP-AES, Atomic Absorption, etc.)
- Traditional preparation methods homogenise samples prior to analysis aiming to eradicate the nugget effect – this is not always the case!
- Homogenising samples reduces the influence of the nugget effect, which in turn masks the true nature of Au mineralisation within an individual sample.

Au-AA25	Au-AA25	Au-AA25
Au	Au Check	Difference
ppm	ppm	ppm
1.68	1.4	0.28
0.45	3.35	2.9
1.6	2.5	0.9
1.24	0.27	0.97
1.7	2.45	0.75
65.4	22.1	43.3

Fig.1: Comparison of duplicate Au assay results using AA technique.

Fig.2: Traditional ICP-MS analysis.

Principle of Nugget EFFect Gold Assay

- NEFFA utilises the nugget effect through numerous systematic analyses of a geological material (typically crushed rock or drill core) to identify the presence of gold or other precious metal based upon its distribution within the sample.
- XRF analysis can detect the presence of Au in geological materials where concentration is >5ppm.
- Materials with Au concentrations of >10ppm are considered to have coarse Au or nuggets, easily detected by XRF.
- Multiple analyses increases the accuracy of data generated. and can help to identify the extent of the nugget effect within an individual sample.
- NEFFA will provide semi-quantitative analyses indicating samples of interest for further analysis, reducing analytical costs.

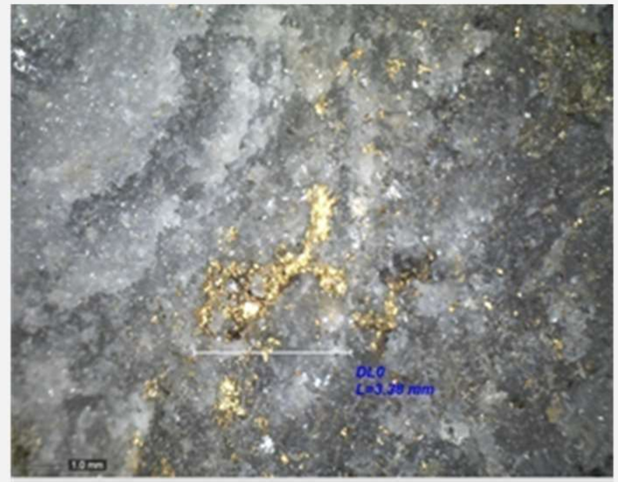
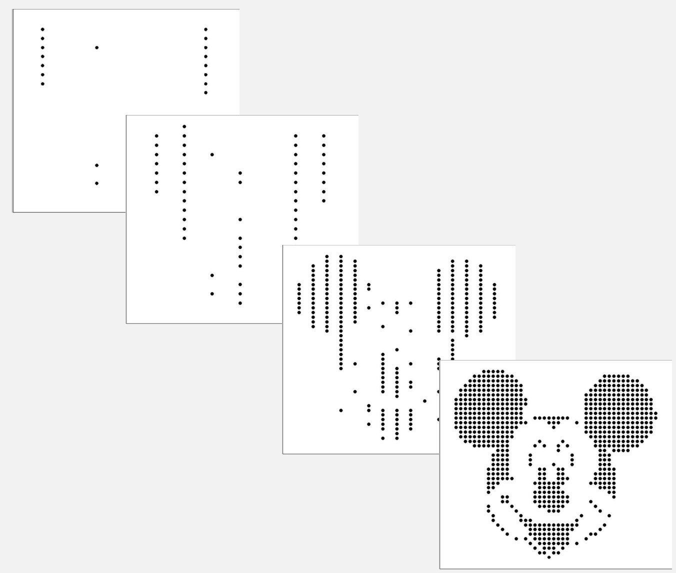


Fig.3: Coarse grained Au in rock sample.



Methodology – Sample Preparation

- Most effective on crushed rock or drill core samples with grain size <3mm, but not homogenised pulp samples.
  - ❖ Rotary Air Blast and RC samples can be analysed directly.
- Sample, with sample size of between 20-30g, depending on nature of material, must be isolated in medium such as a clear sample bag or under plastic film, as to ensure no contamination from an external agent occurs.
- The sample must be distributed evenly over a 10cm x 10cm square with the depth of the material being no thicker than 2mm.
- A grid or 'matrix' must be placed over the sample, with individual matrices measuring 1cm x 1cm.

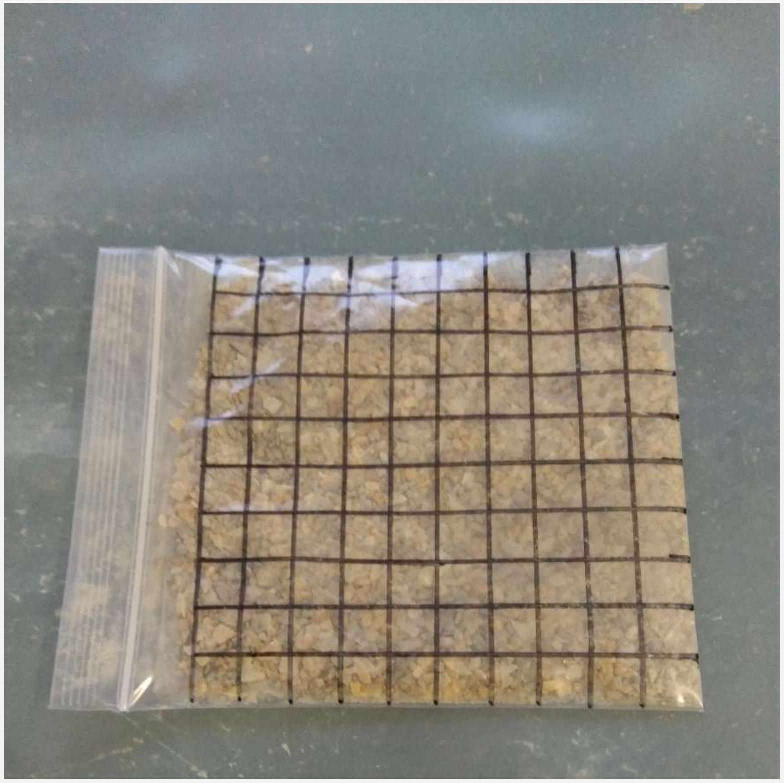


Fig. 4: NEFFA matrix with 1x1cm matrices.

Methodology – Analysis

- Each 1x1cm matrix must be analysed systematically using an XRF analyser.
- Testing has shown that 20 second exposure times are effective for determining the presence of Au.

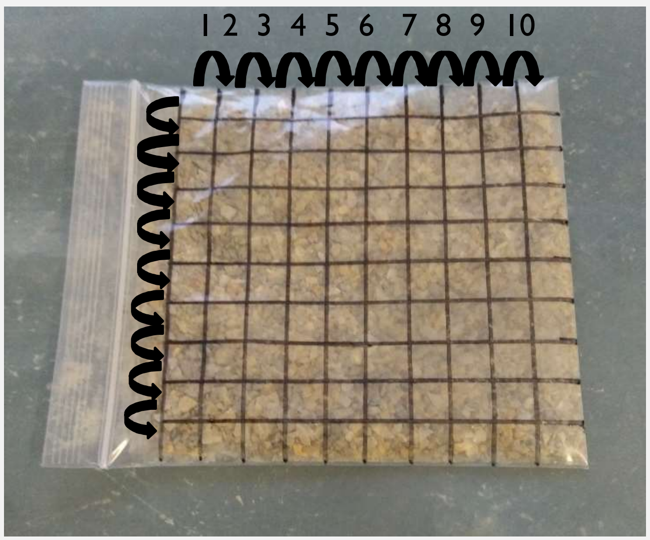


Fig. 5: NEFFA matrix showing the systematic nature of analysis.

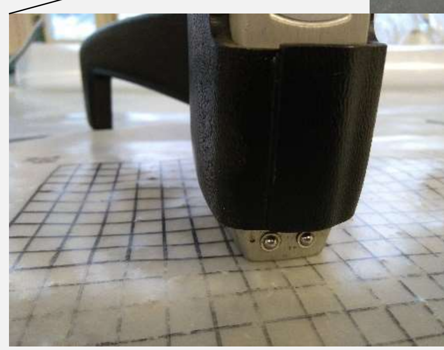


Fig. 6: NEFFA matrix showing the analytical procedure as undertaken using XRF.

Methodology – Results

- As XRF is the preferred instrument of choice for NEFFA, the results are presented in Excel format, downloaded directly from the XRF.
- As analysis is undertaken on a 10 x 10cm matrix, 100 analyses are produced for each sample.

Date	Reading	Sample	Ti	Cr	Mn	Fe	Co	Ni	Cu	Zn	As	Se	Rb	Sr	Zr	Mo	Ag	Cd	Sn	Sb	Ba	Pt	Au	Hg	Pb
08/12/2017	4	1	0	0	91	11057	0	0	0	18	994	0	7	46	20	0	0	0	0	0	0	0	0	0	12
08/12/2017	5	2	0	0	0	11251	0	0	0	21	1061	0	5	41	30	0	0	0	0	0	0	0	23	0	0
08/12/2017	6	3	0	0	130	11897	177	0	0	18	1139	0	8	38	30	0	0	0	0	0	0	0	0	0	0
08/12/2017	7	4	0	0	144	12984	0	0	0	18	1254	0	0	49	40	0	0	0	0	0	0	0	41	0	0
08/12/2017	8	5	0	0	147	12510	194	0	0	17	1162	0	0	44	37	0	0	0	0	0	0	0	29	0	13
08/12/2017	9	6	1183	0	107	11641	0	0	0	20	1098	0	6	48	27	0	0	0	0	0	0	0	0	0	0
08/12/2017	10	7	974	0	153	11817	0	0	0	0	1087	0	6	40	31	0	0	0	0	0	0	0	34	0	15
08/12/2017	11	8	0	0	151	12110	0	0	0	15	1124	0	8	40	30	0	0	0	0	0	0	0	26	0	14
08/12/2017	12	9	0	0	134	11884	0	0	0	17	1162	0	5	42	32	0	0	0	0	0	0	0	0	0	0
08/12/2017	13	10	0	0	124	11983	189	0	0	17	1143	0	6	45	34	0	0	0	0	0	0	0	0	0	17
08/12/2017	14	11	1245	0	124	11013	0	0	0	19	1077	0	6	48	25	0	0	0	0	0	0	0	22	0	15
08/12/2017	15	12	0	0	0	11956	0	0	0	32	1159	0	7	45	35	0	0	0	0	0	0	0	29	0	0
08/12/2017	16	13	0	0	106	12519	0	0	0	17	1212	0	7	45	32	0	0	0	0	0	0	0	0	0	0
08/12/2017	17	14	0	0	106	12123	172	0	0	23	1184	0	8	38	31	0	0	0	0	0	0	0	32	0	14
08/12/2017	18	15	0	0	122	12781	0	0	0	0	1175	0	9	48	40	0	0	0	0	0	0	0	0	0	0

Fig. 7: Results from analysis with concentrations given in ppm.

Methodology – Result Presentation

- Results can be presented in a grid format in order to mirror the structure of the matrix.
- Each result is representative of the corresponding grid in the matrix.

Au	1	2	3	4	5	6	7	8	9	10
1	0	23	0	41	29	0	34	26	0	0
2	22	29	0	32	0	0	0	0	0	0
3	25	25	0	25	0	0	0	0	0	24
4	24	34	0	28	36	0	25	23	0	0
5	33	33	32	33	29	0	0	22	0	0
6	26	0	0	0	0	0	0	25	39	0
7	25	24	0	28	31	27	33	25	34	26
8	28	0	40	23	24	0	27	29	31	0
9	0	0	0	27	0	0	29	0	34	0
10	0	39	0	0	0	0	32	0	0	0

Fig. 8: Results from analysis presented in a grid format mirroring the order of analysis undertaken on the matrix.

Data Analysis

- Data produced by NEFFA can be averaged for the 100 readings, giving an average reading as to the presence or concentration of Au.
- Other statistical methods such as standard deviation can be used to identify the variation in concentration.
- Results produced by NEFFA are comparable with external Au assay.
- Importantly, NEFFA can qualitatively determine the presence of Au.

Datafile	Sample	Average (486 Readings)	Average (100 readings)
1	A0010311	37.82	27.68
2	A0011629	8.51	3.7
3	A0010283	0	0
4	A0011611	0.89	1.09

Sample	ALS Average	Matrix Average (Olympus Delta)	Difference(ALS-Olympus)
M03216	1.06	1.13	0.07
M03805	0.57	1.03	0.46
M06405	2.59	0.25	2.34
M02214	1.41	0.31	1.1
M01114	3.94	0.18	3.77
M01517	3.95	0.38	3.47

Sample	ALS Average	Matrix Average (Innov-X)
M02213	0.091	1.15
M02214	1.41	0.259
M02215	0.502	0.202
M02216	0.112	0.029
M02217	0.059	0

Implications for Exploration

ALS Code	Description	List Price Per Sample (Eur)
BAT-01	Administration Cost	30.00/batch
LOG-22	Log sample in tracking system - Samples received without bar code labels attached	1.15
PREP-31Y	Sample login - Recived without BarCode, Fine crushing - 70% <2mm, Split Sample - Boyd Rotary Splitter, Pulverize 250g split to 85% <75 um	6.40 + 0.65kg
DRY-22	Drying of excessively wet samples in drying ovens that are controlled to a maximum temperature of 60C. Applicable to most soil and sediment samples that are analyzed for volatile elements.	2.35 + 0.55kg
Au - AA23	Au by fire assay and AAS 30 g nominal sample weight	12.25
Total	Average per drill hole sample as submitted by M.E.N Finalnd	21.15

Fig. 9: Breakdown of the costings for Au assay.

- Costs for external Au assays are typically high, along with additional costs (transport, storage, disposal, etc.), this imposes a heavy financial burden on exploration and mining companies.
- Average cost per sample can be in excess of €21.00 per sample.
- As discussed, NEFFA can detect the presence of Au in any hard rock or DH sample, therefore eradicating the need to send all samples from a single project for Au assay, reducing the cost of exploration.

Implications for Exploration

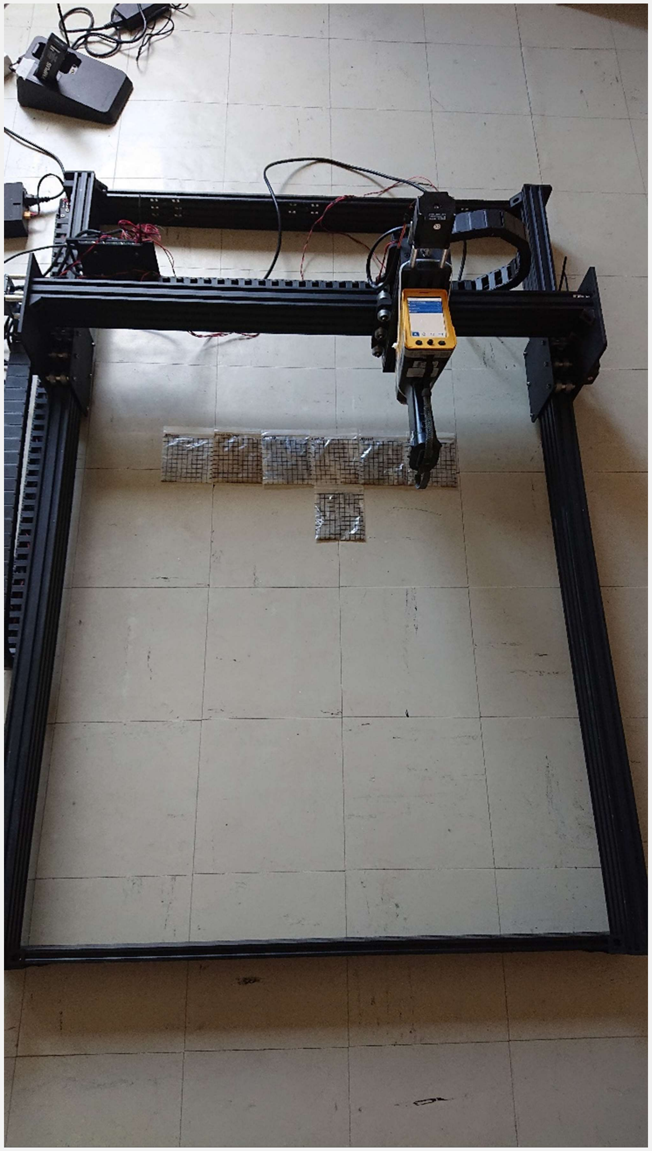
SAMPLE	Au
DESCRIPTION	ppm
M01320	<0.005
M01401	<0.005
M01402	0.01
M01403	<0.005
M01404	<0.005
M01405	0.014
M01406	0.014
M01407	<0.005
M01408	<0.005
M01409	<0.005
M01410	<0.005
M01411	<0.005
M01412	<0.005
M01413	0.045
M01414	<0.005
M01415	<0.005
M01416	<0.005
M01417	<0.005
M01501	0.016
M01502	<0.005
M01503	<0.005
M01504	<0.005
M01516	0.024
M01517	3.95
M01518	0.223
M01601	0.018
M01602	0.007
M01606	<0.005

SAMPLE	Au
DESCRIPTION	ppm
M01320	<0.005
M01401	<0.005
M01402	0.01
M01403	<0.005
M01404	<0.005
M01405	0.014
M01406	0.014
M01407	<0.005
M01408	<0.005
M01409	<0.005
M01410	<0.005
M01411	<0.005
M01412	<0.005
M01413	0.045
M01414	<0.005
M01415	<0.005
M01416	<0.005
M01417	<0.005
M01501	0.016
M01502	<0.005
M01503	<0.005
M01504	<0.005
M01516	0.024
M01517	3.95
M01518	0.223
M01601	0.018
M01602	0.007
M01606	<0.005

SAMPLE	Au
DESCRIPTION	ppm
M01402	0.01
M01405	0.014
M01406	0.014
M01413	0.045
M01501	0.016
M01516	0.024
M01517	3.95
M01518	0.223
M01601	0.018
M01602	0.007

- NEFFA can identify which samples should be sent to external lab for Au assay.
- From the example, of the 28 samples collected, NEFFA can reduce the number of samples for analysis to 10.
- Based on cost of analysis being €21.15 per sample, NEFFA reduces the cost of this batch from €592.20 to €211.50 – a saving of €380.70 – a 64% reduction in cost.

NEFFA automation



- NEFFA production rate could be scientifically increased by automation with the use of CNC platform.

- Video presentation

Conclusions

- NEFFA provides an accurate method of semi-quantitatively identifying Au concentrations in geological materials such as crushed rock and drill samples.
- Provides large datasets, which improve the accuracy and precision of analysis, not just for Au, but all other elements.
- The methodology itself is non-destructive and requires minimal sample preparation, therefore is unsophisticated and environmentally safer (no chemical agents).
- NEFFA can significantly reduce the cost of analyses, through identifying which samples are worthy of further assay and which are not; and as a result, reduce the cost of exploration programs.