



# GENERANDO INFORMACIÓN GEOQUÍMICA PARA LA SOCIEDAD: ANÁLISIS DE MUESTRAS Noviembre 2025



Portable X ray Fluorescence  
(pXRF)  
Experience from practice

URMG-LNEG-PORTUGAL

M.J.BATISTA

IGME-CSIC- ESPANHA

I. MARTIN

<https://asgmi.org/pt/grupo-de-expertos-en-geoquimica/>



CSIC  
CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS



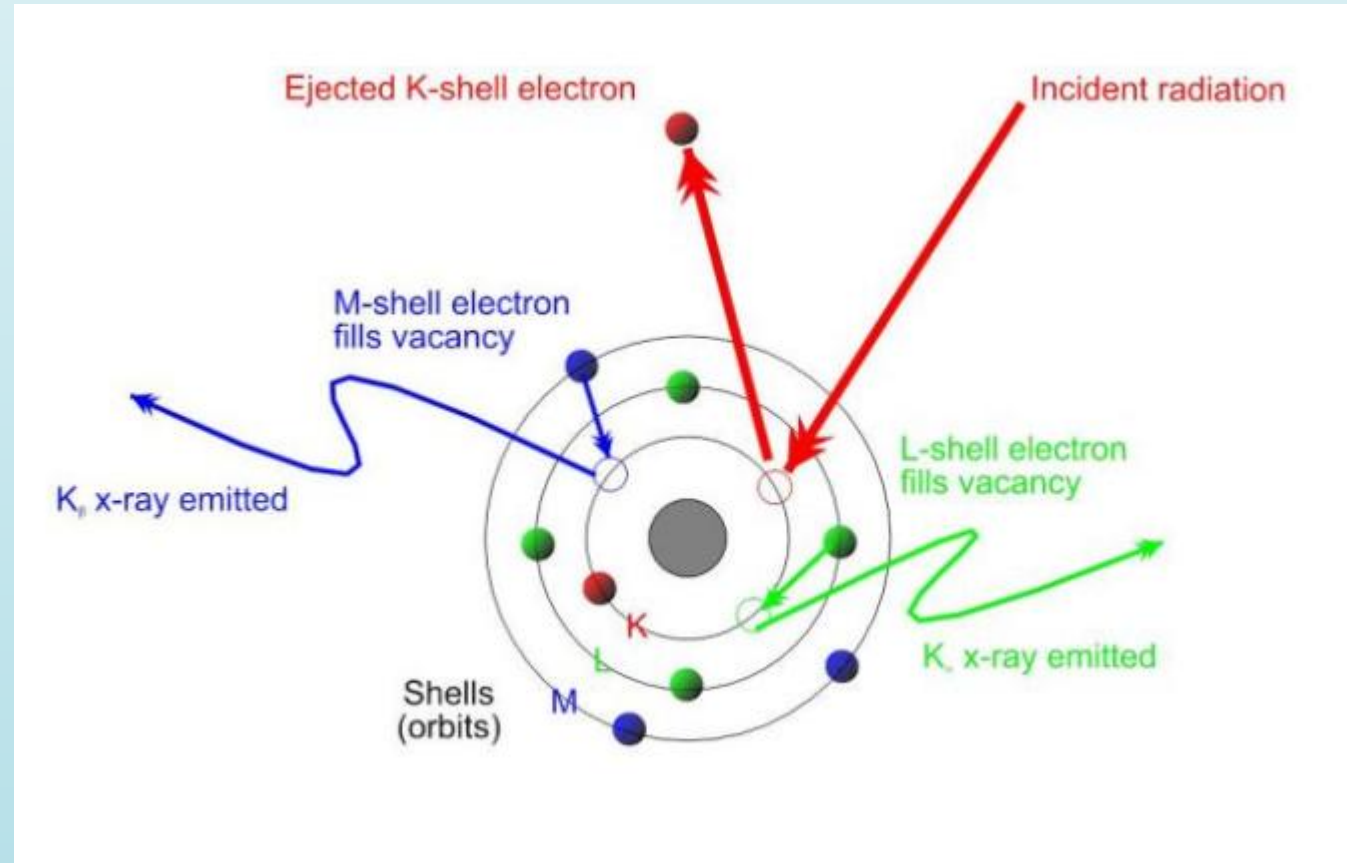
IGME  
INSTITUTO GEOLÓGICO Y MINERO DE ESPAÑA

Portable X-ray Fluorescence (pXRF) equipment allows for rapid in situ analysis of various geological materials in a short period of time. While the detection limits of each element are limited, the presence of detectable quantities can be a valuable aid to field teams, directing surveys and sampling to more favourable areas, saving time and resources.



# How does the equipment work?

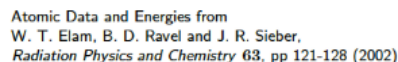
A process whereby electrons are displaced from their atomic orbital positions, releasing a burst of energy characteristic of a specific element. This release of energy is then registered by the detector in the XRF instrument, which in turn categorizes the energies by element.







# X-ray Absorption and Emission Energies of the Elements



Common oxidation states from wikipedia.org, after  
N. N. Greenwood and A. Earnshaw,  
*Chemistry of the Elements*, 2nd ed. (1997).

All energies in eV.  
Emission line strengths are approximate, and vary with element.

<https://xrayabsorption.org/xraytable>  
Version 4, 2020-April-19



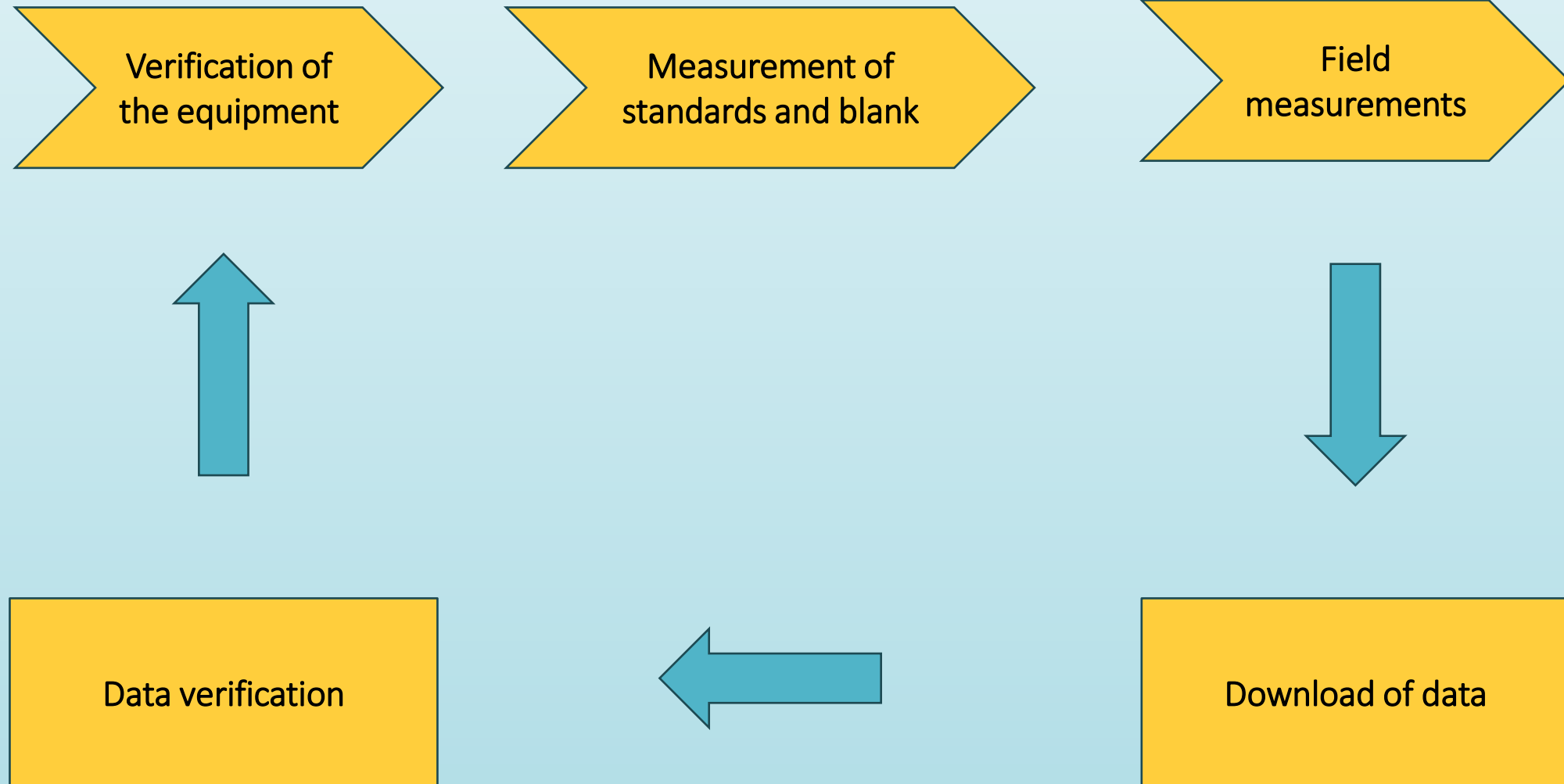


## **Each element produces a unique footprint**

Electrons are fixed at specific energies in their positions in an atom, and this determines their orbits. Additionally, the spacing between the orbital shells of an atom is unique to the atoms of each element, so an atom of potassium (K) has different spacing between its electron shells than an atom of gold (Au), or silver (Ag), etc.

The actual time required for a measurement will depend on the nature of the sample and the levels of interest. High percentage levels will take a few seconds while part-per-million levels will take a few minutes.

## Field chemical analysis





1 – 3 mm-diameter analysis window

2 – Proximity window

3 – Protection cap

4 – On/Off

5 – RX turn on light

6 – touch monitor

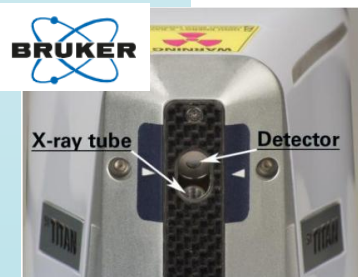
7 – Analysis trigger

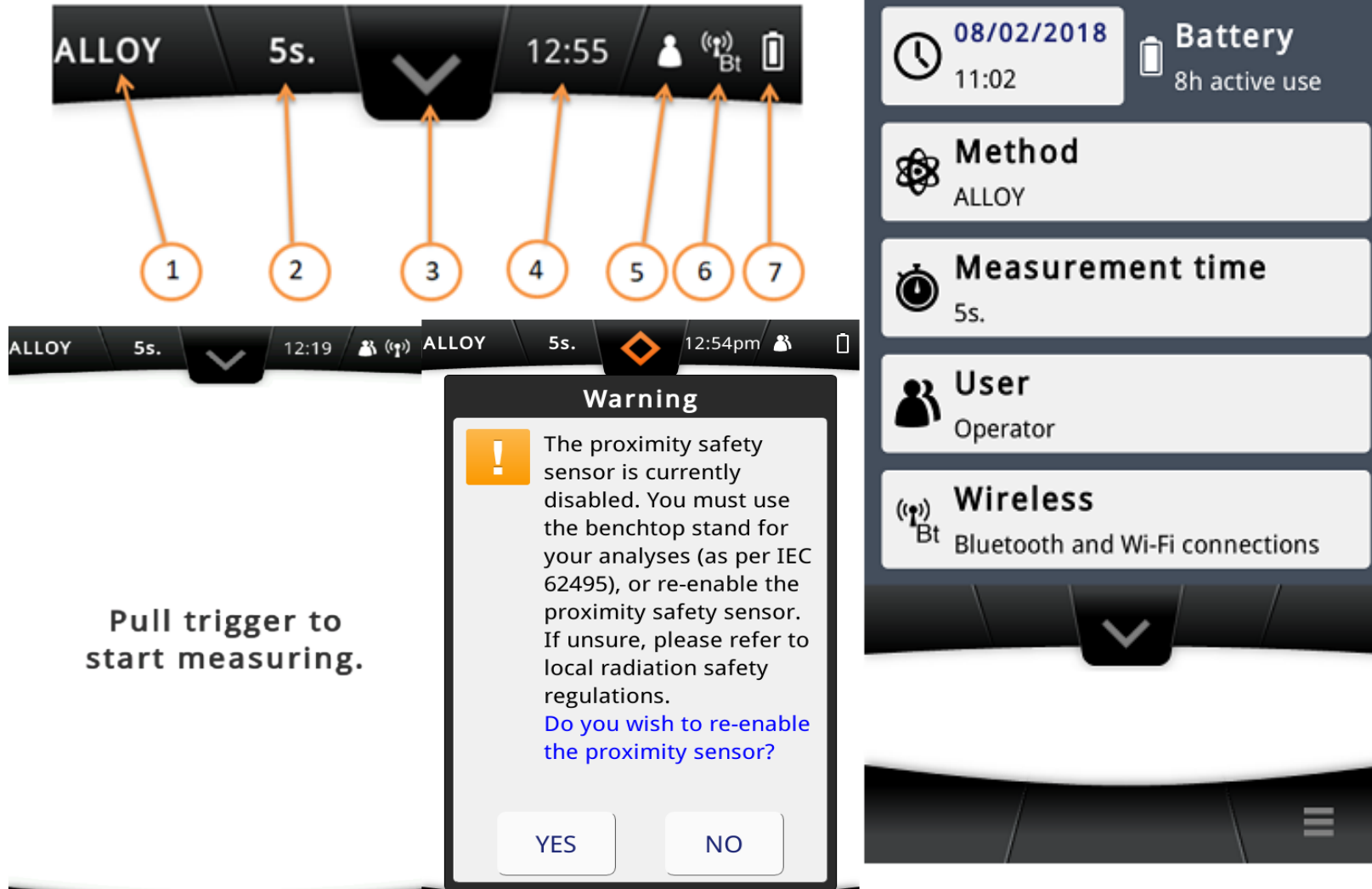
8 – Battery

9 – open battery container

10 – string ring

11 – USB





**1** ALLOY

**2** 5s.

**3** [Down Arrow]

**4** 12:55

**5** [User Icon]

**6** [Bluetooth Icon]

**7** [Battery Icon]

**Pull trigger to start measuring.**

**Warning**

! The proximity safety sensor is currently disabled. You must use the benchtop stand for your analyses (as per IEC 62495), or re-enable the proximity safety sensor. If unsure, please refer to local radiation safety regulations.

[Do you wish to re-enable the proximity sensor?](#)

YES NO

**08/02/2018**  
11:02

**Battery**  
8h active use

**Method**  
ALLOY

**Measurement time**  
5s.

**User**  
Operator

**Wireless**  
Bluetooth and Wi-Fi connections



## Sample recording data and sample reference

ALLOY 5s. 12:56pm

### SAMPLE INFORMATION

**Set Sample Name**  
Noname 1

**Set Average Result Name**  
Average 1

**Set Sample Properties**

Additional Information:

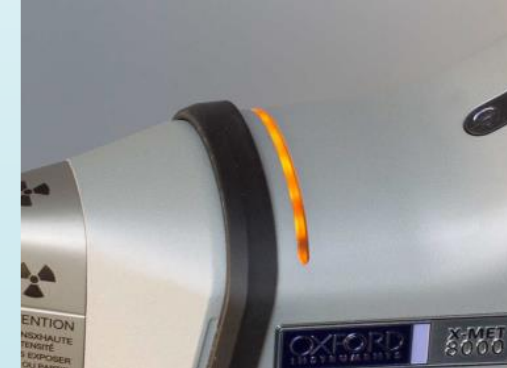
ALLOY 5s. 12:57pm

### Set Sample Name:

Sample 1

1 2 3 4 5 6 7 8 9 0  
q w e r t y u i o p  
a s d f g h j k l  
z x c v b n m , .  
↑ #! ←

Please note that your body should be as far away from the device as possible when taking the measurement.



ALLOY 30s. 12:11pm			
NONAME 9			
<b>SS316</b>			
POSSIBLE MATCH (1/2)			
MEASURING IN PROGRESS... 2s			
ELEMENT	%	+/-	LIMIT
Fe	68.65	0.662	60.00 - 73.00
Cr	17.49	0.316	16.00 - 18.00
Ni	8.96	0.282	10.00 - 14.00
Mo	2.94	0.056	2.00 - 3.00
Mn	1.45	0.094	0.00 - 2.00
Pd	0.29	0.034	
Cu	0.23	0.039	
C	0.00	0.000	





ALLOY 5s. 12:11pm

NONAME 10

**SS316**

POSSIBLE MATCH (1/2)

ELEMENT	%	+/-	LIMIT
Fe	68.70	0.895	60.00 - 73.00
Cr	17.35	0.428	16.00 - 18.00
Ni	8.75	0.372	10.00 - 14.00

1	Name	Comment	Class	Date	Time	Duration	Reference	Pass/Fail	Grade	GPS Lat.	GPS Long.	Additional	Camera In Na	+/-	Mg	+/-	Al	+/-	Si	+/-	P
2	lutala1		REE-FP	22.6.2021	07:54:50	120			AI-5005(0.6604) AA-1100(0.6618)				img000016.png								
3	lutala2		REE-FP	22.6.2021	08:05:38	120							img000017.png								
4	lutala3		REE-FP	22.6.2021	08:13:07	120							img000018.png								
5	4		REE-FP	22.6.2021	08:24:16	120							img000019.png								
6	5		REE-FP	22.6.2021	09:00:18	120							img000020.png								
7	6		REE-FP	22.6.2021	09:06:06	120							img000021.png								
8	295C-A05-I		REE-FP	22.6.2021	11:01:27	120							img000022.png								
9	295C-A05-I		MiningLE-FP	22.6.2021	11:06:55	60							img000024.png		0.8185	0.0798	9.6601	0.0345	25.912	0.0287	0.34
10	295C-A0		MiningLE-FP	22.6.2021	11:16:37	60							img000025.png		0.4255	0.1015	10.8644	0.0429	29.4568	0.0366	0.28
11	295C-A0		REE-FP	22.6.2021	11:27:27	120							img000026.png								
12	295C-A06-I		REE-FP	22.6.2021	11:49:41	120							img000027.png								
13	295C-A06-I		MiningLE-FP	22.6.2021	11:52:32	60							img000028.png		0.8369	0.0786	10.2136	0.0355	29.7437	0.0312	0.1
14	295C-A07-S		REE-FP	22.6.2021	12:17:32	120							img000029.png								
15	295A-A01-I		REE-FP	22.6.2021	13:24:15	120							img000031.png								
16	295A-A01-I		MiningLE-FP	22.6.2021	13:27:01	60							img000032.png		0.3596	0.0732	10.3802	0.0355	30.7428	0.0318	0.13
17	295A-A02-I		REE-FP	22.6.2021	13:41:29	120			AA-1100(0.8047) AI-5005(0.8483)				img000033.png								
18	295A-A02-I		MiningLE-FP	22.6.2021	13:43:58	60							img000034.png		0.4201	0.1035	13.869	0.0509	21.7051	0.0335	0.14
19	295A-A0		REE-FP	22.6.2021	13:56:46	120							img000035.png								
20	295A-A03-C		REE-FP	22.6.2021	14:15:49	120							img000036.png								
21	295A-A03-C		MiningLE-FP	22.6.2021	14:18:46	60							img000037.png		0.3678	0.0681	12.8915	0.0378	21.1577	0.0253	0.10
22	295A-A0		REE-FP	22.6.2021	14:35:05	120			AI-6262(2.7865) AA-6151(2.8641)				img000038.png								
23	295A-A04-I		REE-FP	22.6.2021	14:55:32	120							img000039.png								
24	295A-A04-I		MiningLE-FP	22.6.2021	14:58:09	60							img000040.png		0	0	9.6859	0.0307	30.6275	0.0282	0.0
25	295A-A05-S		REE-FP	22.6.2021	15:18:27	120			AI-5005(2.2002) AA-5086(2.2995)				img000041.png								
26	295A-A05-S		MiningLE-FP	22.6.2021	15:20:43	60							img000042.png		0.4534	0.0913	14.9322	0.0497	21.9773	0.0321	0.10
27	295A-A06-I		REE-FP	22.6.2021	15:35:20	120							img000043.png								
		SNtotal	295Aold	295B	295B_REE	295C	295C_REE	295D	295D_REE	Sheet11	padroes	duplicados									

## Field day routine:

Before each measurement or at the end of a workday:

1) The integrity of the entire system should be checked, in particular, whether the analysis window is damaged. If the window is damaged, it should be replaced immediately. It should be noted that this window is the detector's first line of defence, so its damage may compromise the integrity of the detector itself.

In order to extend the life of the window, some precautions should be taken during the measurement.

2) Turn on the equipment and GPS at least 5 minutes before taking the measurement so that the equipment signal stabilizes;

3) At the end of the day a set of analyses should be performed on the blank ( $\text{SiO}_2$ ) and on a standard sample. This data should be recorded on the device and downloaded along with the rest of the data at the end of the week. This data will be used to detect any analytical deviations in the device.





## Field day routine:

Name	Class	Duration	S (%)	Ca (%)	Ti (%)	Cr (%)	Mn (%)	Fe (%)	Ni (%)	Cu (%)	Zn (%)	Pb (%)
356-A GBM911-15	Mining-FP	60	8.0449	3.8947	0.113	0.0774	0.0763	14.6325	2.2827	0.5027	0.0229	0.0239
356-A GBM911-15	Mining-FP	60	8.3739	3.9006	0.1172	0.0772	0.078	14.6212	2.2607	0.5002	0.0224	0.0225
356-A GBM911-15	Mining-FP	60	7.8797	3.896	0.1176	0.0683	0.0735	14.4815	2.2646	0.5072	0.0219	0.0231
356-A GBM911-15	Mining-FP	60	7.9522	3.8784	0.1176	0.0725	0.0809	14.4442	2.2408	0.4999	0.0211	0.0236
356-A GBM911-15	Mining-FP	60	7.695	3.7733	0.114	0.0692	0.0751	14.1021	2.1894	0.469	0.0215	0.0219
356-A GBM911-15	Mining-FP	60	7.8028	3.8346	0.1126	0.0769	0.0824	14.5021	2.2683	0.5048	0.0233	0.0234
356-A GBM911-15	Mining-FP	60	7.9812	3.7435	0.1151	0.0681	0.0692	14.3223	2.2815	0.4946	0.0237	0.0246
356-A GBM911-15	Mining-FP	60	7.8183	3.7511	0.1165	0.0737	0.0847	14.4462	2.3078	0.5067	0.0236	0.0233
356-A GBM911-15	Mining-FP	62	8.942	4.1465	0.1238	0.0676	0.0896	15.6941	2.4206	0.5835	0.0277	0.0278
Certificado	Mining-FP	60	8	3.77	0.114	0.084	0.084	14.78	2.28	0.502	0.026	0.026

Blanks also have certified values that can be expected, higher than those, the worker should consider contamination of the window. To check for contamination, the worker should measure reference materials before and after cleaning the window to observe differences.



Geological materials are typically quite **heterogeneous**. Therefore, there can be significant geochemical variability due to various factors such as variations in texture, mineralogy, alteration, color, hardness, rock structure, or the presence of mineralizations.

Thus, whenever possible, it is advisable to obtain as many analyses as possible on a given point (4 to 5 are recommended for rocks and 6 to 7 for areas where mineralizations are suspected) to obtain the most complete geochemical characterization possible of the object under study. The example below should be followed.



Sample moisture attenuates the XRF signal (Parsons et al. 2012) and sample inhomogeneity induces measurement irreproducibility (Gazley and Fisher 2014); Therefore,

**Wet days measurements need to be avoided**

# GRACIAS POR SU ATENCIÓN

**URMG-LNEG-PORTUGAL**

**M.J.BATISTA**

**IGME-CSIC- ESPANHA**

**I. MARTIN**