Insights into Exploration Geochemistry (2): Benefits and Challenges of portable XRF devices

Last month I compiled my thoughts about different digestion methods used in mining and mineral exploration. But what is the alternative to digestion-based analytical chemistry? For a number of years, so called portable XRF (pXRF) devices have been trialled and tested and many publications compiled assessing the pro's and con's of these devices. Recent technological advances even have resulted in the development of portable XRD (pXRD) which will allow instant analysis of mineralogy on site. In this article I will outline my personal experiences with pXRF technology.

This topic and more are covered in my lectures and workshop "Advanced Mineral Exploration Geochemistry: Best practice industry methods and workflows", available to students and professionals alike.

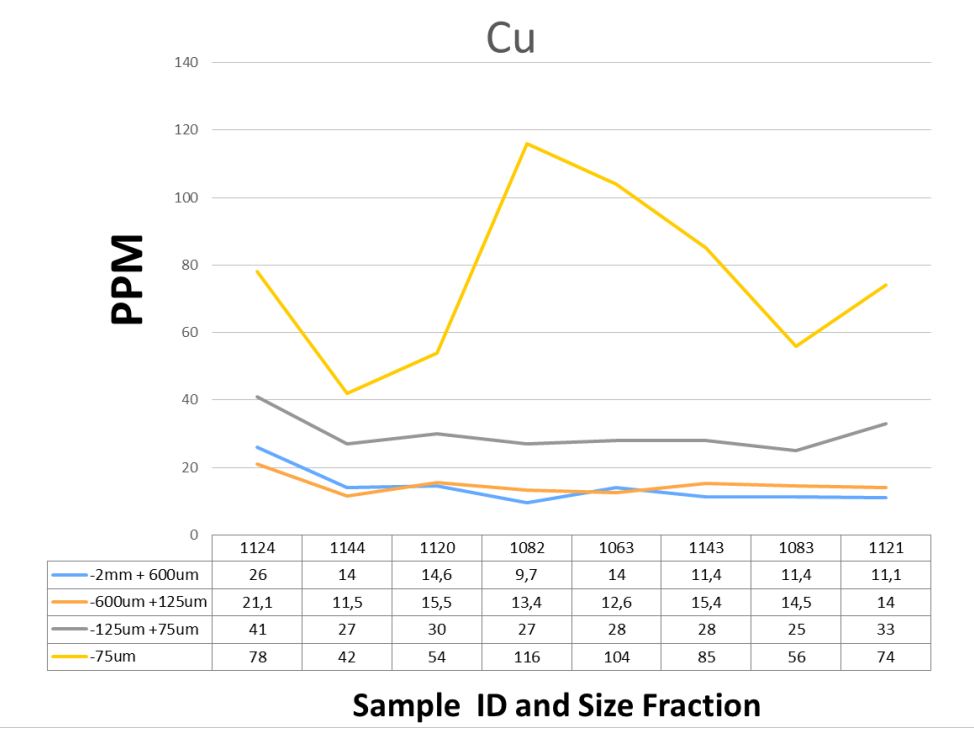
pXRFs take the lab into field and work by determining the chemistry of a sample by measuring the secondary X-ray emitted from a sample when it is excited by a primary X-ray source. Each element present in a sample typically produces a set of secondary X-rays considered unique for that specific element.

XPLORE GLOBAL Ltd. | Based in Maidenhead, UK | Email: info@xplore.global

The advantages of the technology are straightforward. To name a few:

- After initial equipment purchase, you can zap as many samples as you like
- The assays are quick and easy to repeat leading to improved and timely decision-making in the field
- If appropriately trained, field technicians can take over assaying and databasing
- Works well where detection limits are not an issue
- Tailored recording modes, e.g. soil vs. mining modes
- pXRF can be used for geochemical orientation studies in the field

Below is an example of an orientation study before actual field sampling was carried out to assess an area for vein-hosted copper deposits. This study looked at the response of the aforementioned elements in different soil horizons and grain fractions.

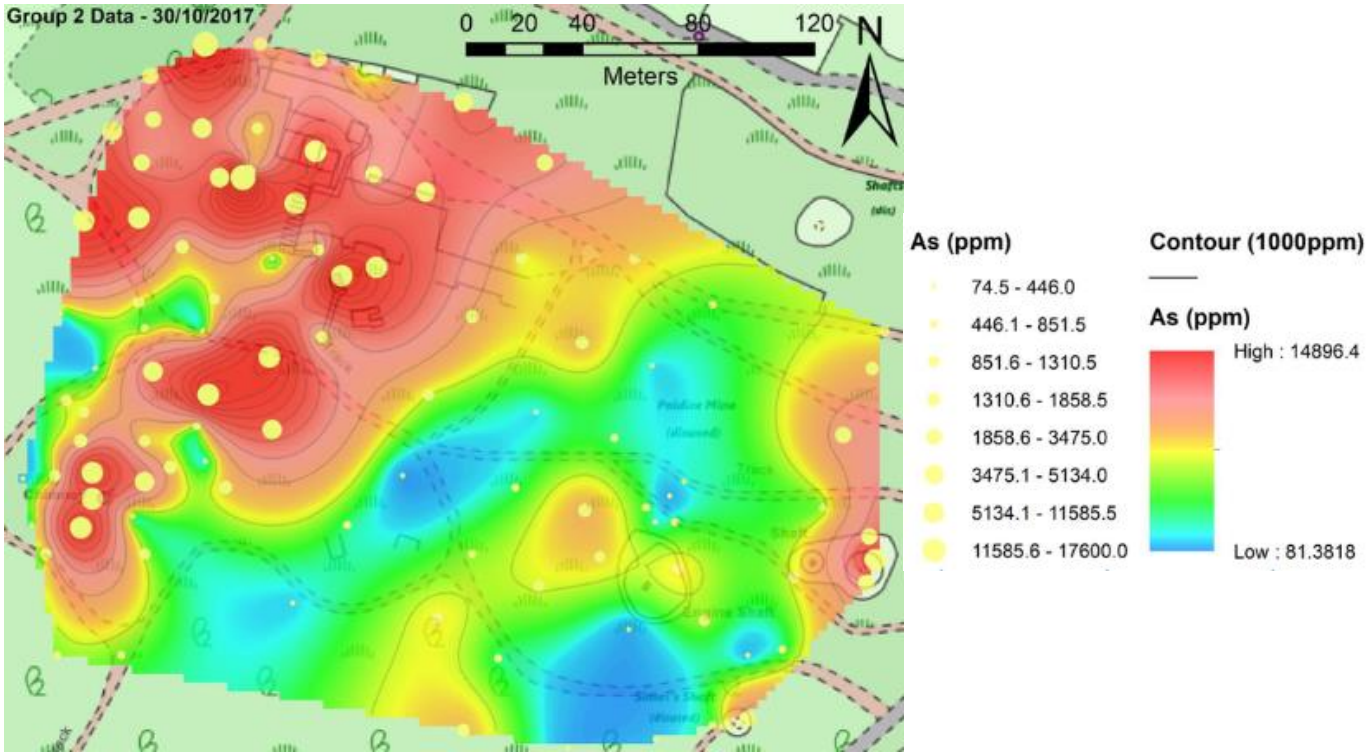


	1124	1144	1120	1082	1063	1143	1083	1121
-2mm + 600um	26	14	14,6	9,7	14	11,4	11,4	11,1
-600um +125um	21,1	11,5	15,5	13,4	12,6	15,4	14,5	14
-125um +75um	41	27	30	27	28	28	25	33
-75um	78	42	54	116	104	85	56	74

As you can see, the optimal grain size -75um. I usually leave the participants of my workshops to come up with an explanation for this. What do you think happened?

XPLORE GLOBAL Ltd. | Based in Maidenhead, UK | Email: info@xplore.global

Another study across a contaminated historic mine site provided a straightforward link to mining infrastructure. Here, detection limits are not an issue and we actually are interested in elevated, pct-level anomalies.

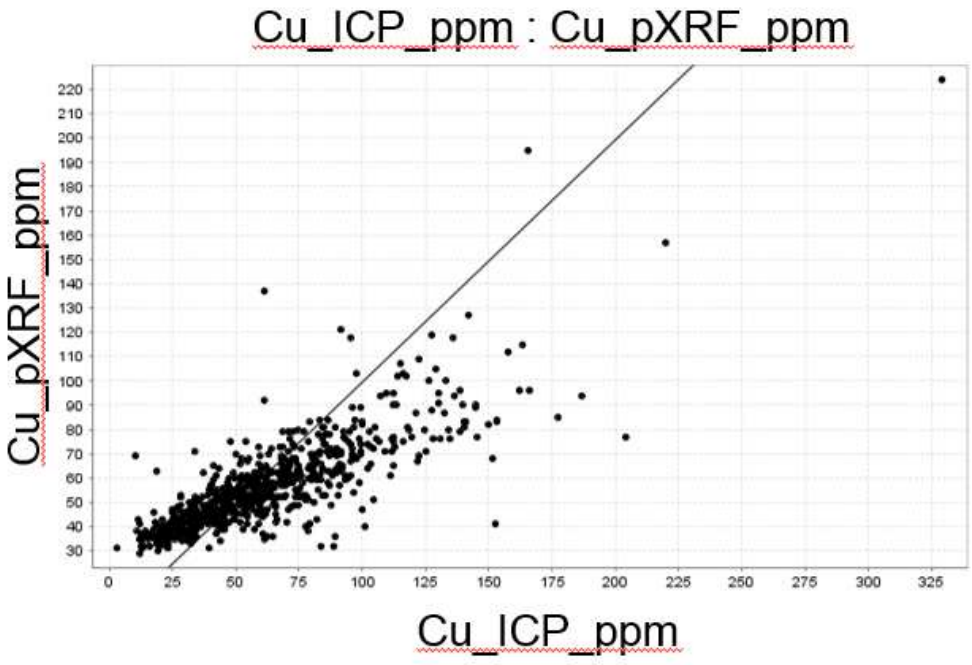


However, despite the positives outlined, there are still a few challenges that will have to be overcome:

- Sample prep (ideally) required: I am cautious when it comes to zapping samples that are wet and not homogenised. Moist or wet samples will reduce the effectiveness of the XRF beam and the lack of homogenisation will result in nugget effects, for example.
- QC: It is also highly recommended to regularly use blanks and standards to control the quality of assays.
- Bias: I have observed geologists zapping randomly mineralised sequences in core and recording these as intervals in the database. This will introduce a strong bias and is not representative. Instead, you should scan the entire drill interval.

XPLORE GLOBAL Ltd. | Based in Maidenhead, UK | Email: info@xplore.global

- Detection limit as with all pXRFs are problematic. Whilst base metals usually will give comparable assays to chemical methods using digestion, the use of pXRF will particularly impact trace element studies where assays close or below crustal abundances are targeted to vector towards mineralisation. Unfortunately, a pXRF will not be as useful, if you are looking for these petrogenetic vectors.
- Depending on the device, elements with similar peak energies cannot be resolved, such as Cu or Ta. Both elements are important to study a number of ore deposits.
- Still, pXRFs tend to over- or underestimate assay values depending on what you are looking at. The image below shows assay values for Cu across a copper greenfields terrane both analysed using pXRF and ICP-MS Four Acid Digest (4AD). Higher values (>50 ppm) are definitely more reliable using digestion-based chemistry.



In summary, I believe that pXRF is a very useful tool for mining and mineral exploration applications, but you need to pay attention to the pitfalls when using the device for routine surveys. Benedikt Steiner, 07/01/2018

XPLORE GLOBAL Ltd. | Based in Maidenhead, UK | Email: info@xplore.global