

Combining chemical and hyperspectral data, can a portable XRF instrument help?



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The new generation of portable X-ray fluorescence instruments (PXRF) is popular in metal- and mining industry as well as environmental pollutions studies due to their capacity to determine in situ heavy metals in concentrations above a few tens of mg/ton (ppm). The latest detectors now allow also determining lighter elements like Mg, Al, Si, P, and S to be measured especially when the system is purged with He or under vacuum.

The Faculty of ITC, University of Twente in the Netherlands, recently acquired a PXRF, a Niton XL3t GOLDD+ for research in combination with its NIR and TIR equipment and for mineral exploration and environmental studies. The PXRF instrument determines element concentrations in around one minute depending on chosen filters. A small video camera in the instrument allows selection of the exact 8mm diameter spot on which the measurement takes place. The fluorescence spectra are also stored together with concentration and video picture. With a small Helium gas cylinder, which lasts around 24 hours, reproducible field measurements can be made of the light elements. Beforehand or afterwards some matrix corrections are to be made with certified reference material.



Figure. 1: Direct field measurements on rock outcrop

The PXRF instrument can also be used in combination with a laptop and fixed in a lab-mate, see picture. This laboratory set-up allows rapid measurements of series of rock samples as well as soil and sediment

material. For the latter aluminum cups are used with a polypropylene foil taped over a 12 mm hole in the bottom. It is advisable to add a little fan below the lab-mate when continuous measurements are to be made or else the instrument will require cooling time.

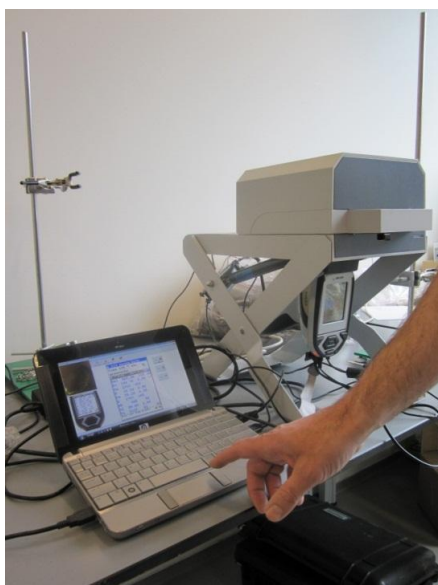


Figure. 2: Laboratory set-up of the same instrument as in figure 1.

The ITC instrument has already been used successfully for the validation of airborne potassium radiometric and other data as part of MSc student training in the Western Harz Mountains, Germany. A number of suspiciously high Lead values were measured in massive sulphide samples of the world scale Rammelsberg SEDEX deposit but these can be explained by interactions of the fluorescence radiation in the detector causing sum peaks or escape peaks in a matrix of >45% Fe. For this kind of interferences and calibration procedures there is little information and the mining & exploration industry have therefore set-up an international working group as part of CAMIRO <http://www.camiro.org/>. This project will provide guidelines for the minerals industry mainly for the use of heavy metal trace elements determinations in soils and drill core.

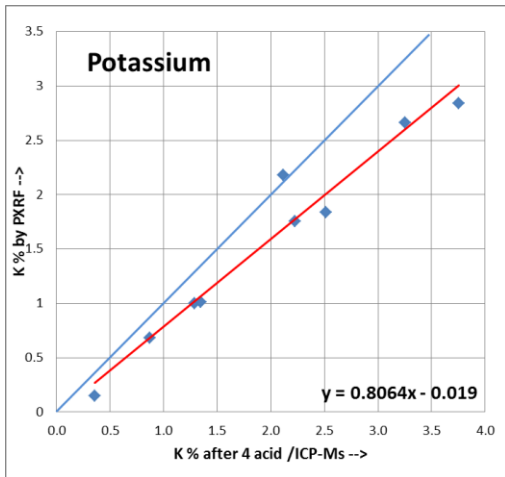


Figure 3: Calibration checks; PXRF measurements for K %, without Helium purging, on Archean Greenstone belt rock slabs from the Pilbara Craton in Western Australia are plotted against K% obtained by ICP-MS after a four acid digestion by Actlabs. An angular correction is required for these Pilbara rocks.

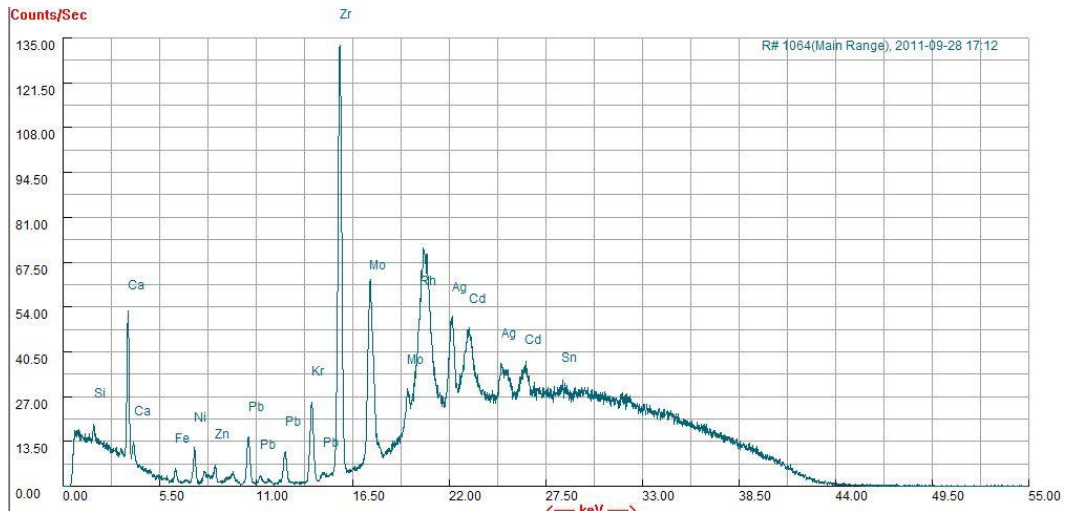


Figure 4 Mining mode measured XRF spectrum of BAM S005b XRF glass standard reference material

The instrument is currently used in our research on the epithermal gold mineralization near Rodalquilar in the south east of Spain. In this arid area hydrothermal alteration, zones of e.g. alunite, are exposed at the surface and have been mapped in the past using traditional field geologic methods in combination with geochemistry (Arribas et al., 1995). For a number of years ITC has worked at Rodalquilar on the combined use of IR spectroscopy and near-infrared (ASD) field spectrometry in combination with hyperspectral HYMAP data interpretation and analysis (van der Meer et al., 2011). The combined results do not optimally delineate mineralization. The present research is testing the hypothesis that PXRF can be used successfully in the Rodalquilar area to deduce lithologies and hydrothermal alteration zones. The second more important objective is to see if PXRF data in combination with VNIR and SWIR spectrometric data can accurately locate areas of the known epithermal Au mineralization. For this purpose rock samples collected at about 150 to 200 meter interval over two more or less perpendicular 4 km long traverses crossing the main epithermal system are being used. The results are awaited.

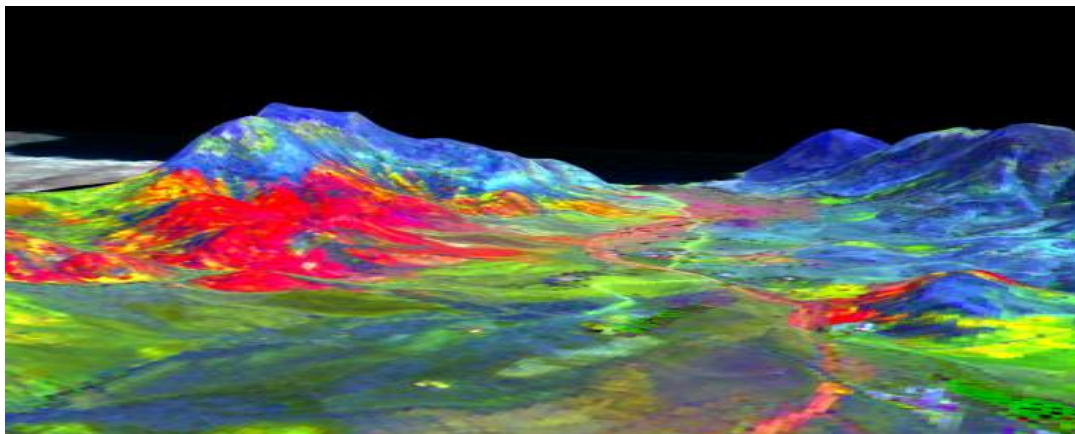


Fig. 4 Hydrothermal alteration in the Los Tollo extension on the Rodalquilar Au Deposit. In red = alunite , in blue mainly younger carbonate cover

Users of PXRF for light elements such as Mg, Al and Si are scarce and there are still problems for accurate determinations of these elements. Recently we started a small Dutch Niton user group with joint interest in these light elements in rocks. The participants, aside of ITC, are in the field archeology, paleo-magnetism and environmental applications. First step is to acquire a suitable set of glass XRF reference samples calibration corrections and selecting suitable fine-grained rock slabs for quality control in the field.

References

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See also: <http://www.sciencedirect.com/science/article/pii/S0303243411001103>