

# Precious Element Analysis in Lead and Zinc Processing with Thermo Scientific ARL PERFORM'X Series Advanced X-Ray Fluorescence Spectrometers

Christopher R. Shaffer, Thermo Fisher Scientific, Ecublens, Switzerland

## Key Words

ARL PERFORM'X 2500W, precious metal, minerals processing, X-ray fluorescence, XRF

## Goal

The goal of this application note is to state the precision and accuracy of the ARL PERFORM'X in trace elemental analysis of gold and silver in mineral processing.

## Introduction to Lead and Zinc Processing

Lead and zinc can be produced pyrometallurgically or hydrometallurgically, depending on the type of ore used as a charge. In the pyrometallurgical process, ore concentrate containing lead, zinc, or both is fed, in some cases after sintering, into a primary smelter. Lead concentrations can be 50-70%, and the sulfur content of sulfidic ores is in the range of 15-20%. Zinc concentration is in the range of 40-60%, with sulfur content in sulfidic ores in the range of 26-34%. During sintering, a blast of hot air or oxygen is used to oxidize the sulfur present in the feed to sulfur dioxide (SO<sub>2</sub>). Blast furnaces are used in conventional processes for reduction and refining of lead compounds to produce lead bullion. This refining process removes any remaining nonlead materials (e.g., gold, silver, bismuth, zinc, and metal oxides such as oxides of antimony, arsenic, tin, and copper).



While the gold and silver are considered to be pollutants in the refinement process, these elements can be more profitable than the primary ore elements. It is for this reason that the accurate trace analysis for silver and gold in the ore material is essential. The quickest and best method for this analysis is wavelength dispersive x-ray fluorescence.

## Instrument

Thermo Scientific ARL PERFORM'X series spectrometer used in this analysis was a 2500 watt system. This system is configured with 6 primary beam filters, 4 collimators,

up to nine crystals, two detectors, helium purge and our 5GN+ Rh X-ray tube for best performance from ultra-light to heaviest elements thanks to its 50 micron Be window. This new X-ray tube fitted with a low current filament ensures an unequalled analytical stability month after month.



The ARL PERFORM'X offers the ultimate in performance and sample analysis safety. Its unique LoadSafe design includes a series of features that prevent any trouble during sample pumping and loading. Liquid cassette recognition prevents any liquid sample to be exposed to vacuum by mistake. Over exposure safety automatically ejects a liquid sample if X-ray exposure time is too long.

The Secutainer system protects the primary chamber by vacuum collecting any loose powders in a specially designed container, easily removed and cleaned by any operator. For spectral chamber protection, the ARL PERFORM'X uses a helium shutter designed for absolute protection of your goniometer during liquid analysis under helium operation. In the "LoadSafe Ultra" optional configuration, a special X-ray tube shield provides total protection against sample breakage or liquid cell rupture.

## Samples and methods

The samples were all fine powders and pressed into solid pellets without the addition of any binding agent. All calibration samples were synthetically created.

## Results and discussion

Table 1 on next page shows the analytical conditions used, while Table 2 demonstrates the good sensitivity of the method and the limits of detection achieved.

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Elements	Line	Crystal	kV	mA	Counting time (s)
<b>Ag</b>	K $\alpha$	LiF200	60	40	60
<b>Au</b>	L $\alpha$	LiF200	50	50	200
<b>Au</b>	L $\beta$	LiF200	50	50	200
<b>As</b>	K $\beta$	LiF200	50	50	30
<b>Cd</b>	K $\alpha$	LiF200	60	40	30
<b>Cu</b>	K $\alpha$	LiF200	50	50	20
<b>Fe</b>	K $\alpha$	LiF200	50	50	20
<b>Pb</b>	L $\beta$	LiF200	50	50	20
<b>Zn</b>	K $\alpha$	LiF220	50	50	20

Table 1: Analytical conditions

Elements	SEE	R2	LoD
<b>Ag</b>	0.01%	0.9989	NA
<b>Au L<math>\alpha</math></b>	0.00%	0.99993	0.18
<b>Au L<math>\beta</math></b>	0.00%	0.99971	0.09

Table 2: Performance and limits of detection  
 SEE - Standard Estimate of Error; NA - Not Analyzed  
 R2 - Regression Correlation Coefficient; LoD - Limit of Detection

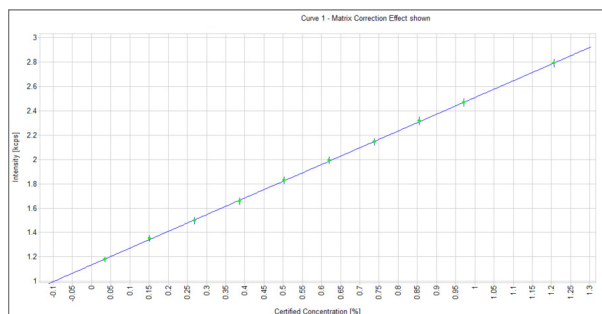


Figure 1: Calibration for silver in mineral ores

Figures 1, 2 and 3 show the calibration lines obtained in the zinc and lead ore materials. With detection limits less than 0.1 ppm for gold in a calibration ranging for 0.5 ppm to 13 ppm, the ARL PERFORM<sup>®</sup>X demonstrates excellent accuracy and sensitivity.

### Precision

The repeatability of a ore sample is shown in Table 3. The results were obtained by analyzing the same sample 10 times. The precision in the table illustrate the incredible stability of the ARL PERFORM<sup>®</sup>X.



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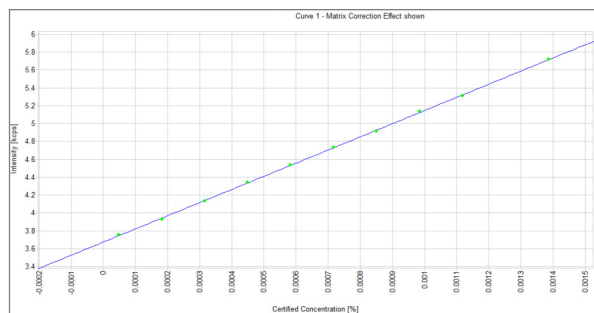


Figure 2: Calibration for Gold in K $\alpha$  in ore minerals

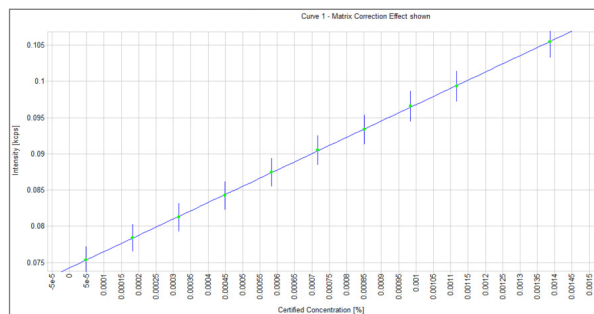


Figure 3: Calibration for Gold K $\beta$  in ore minerals

Line Unit	Ag K $\alpha$ g/ton	Au L $\beta$ g/ton	Au L $\alpha$ g/ton	Cu K $\alpha$ %	Fe K $\alpha$ %	Pb L $\beta$ %	Zn K $\alpha$ %	As K $\beta$ %	Cd K $\alpha$ %
Run 1	339.6	0.56	0.63	0.0231	5.2321	0.6174	0.967	0.0806	0.0081
Run 2	366.3	0.55	0.6	0.0231	5.1961	0.629	0.9694	0.0811	0.0079
Run 3	348.9	0.58	0.59	0.0233	5.2826	0.6047	0.9656	0.0803	0.008
Run 4	349.3	0.47	0.56	0.0233	5.2197	0.6373	0.9648	0.0811	0.0079
Run 5	363	0.47	0.62	0.0233	5.1905	0.621	0.9645	0.0807	0.0079
Run 6	353.7	0.45	0.61	0.0233	5.2367	0.6352	0.97	0.0808	0.0081
Run 7	342.4	0.49	0.58	0.0232	5.205	0.6166	0.9647	0.0805	0.008
Run 8	357.9	0.48	0.57	0.0233	5.2697	0.6283	0.9661	0.0807	0.0079
Run 9	357.8	0.64	0.63	0.023	5.1611	0.6279	0.9675	0.0806	0.008
Run 10	370.5	0.52	0.63	0.0232	5.2437	0.6288	0.9647	0.0807	0.008
<b>Av.</b>	<b>354.9</b>	<b>0.52</b>	<b>0.6</b>	<b>0.0232</b>	<b>5.2237</b>	<b>0.6246</b>	<b>0.9664</b>	<b>0.0807</b>	<b>0.008</b>
<b>SD</b>	<b>10.08</b>	<b>0.06</b>	<b>0.026</b>	<b>0.0001</b>	<b>0.0371</b>	<b>0.0098</b>	<b>0.002</b>	<b>0.0003</b>	<b>0.0001</b>
<b>RSD%</b>	<b>2.84</b>	<b>11.51</b>	<b>4.37</b>	<b>0.46</b>	<b>0.71</b>	<b>1.57</b>	<b>0.21</b>	<b>0.31</b>	<b>0.99</b>

Table 3: 10-run repeatability test on synthetic sample #3

### Conclusion

The very high sensitivity achieved with the ARL PERFORM<sup>®</sup>X XRF spectrometer allows the analysis of silver and gold in lead and zinc ore minerals with excellent precision and accuracy. This ability helps provide a more cost effective and profitable mining operation.

