DELTA HHXRF Analyzers

Limits of Detection (LODs)

LODs, reported in PPM unless otherwise noted, are optimal. Measurements were taken in air for 120 seconds per beam. Standards used were in a clean, homogenous SiO_2 matrix without interfering elements.

Element of Interest	DELTA Premium 3-Beam Soil Ta/Au Tube, SDD	DELTA Premium 3-B Soil & 2-B Mining Rh Tube, SDD	DELTA Classic 3-Beam Soil Au Tube, SiPiN
Mg	Not Available	< 1%	Not Available
Al	Not Available	< 0.5%	Not Available
Si	Not Available	< 0.5%	Not Available
P	500 - 700	800 - 1500	1 - 5%
S	100 - 250	150 - 300	0.1 - 0.5%
Cl	60 - 100	100 - 200	500 - 1000
K	30 - 50	40 - 60	150 - 250
Ca	20 - 30	25 - 40	150 - 250
Ti	7 - 15	7 - 15	20 - 50
Cr	5 - 10	5 - 10	10 - 30
V	7 - 15	7 - 15	10 - 30
Mn	3 - 5	10	10 - 30
Fe	5	10	10 - 30
Co	10 - 20	10 - 20	20 - 40
Ni	10 - 20	10 - 20	20 - 40
Cu	5 - 7	5 - 7	15 - 30
Zn	3 - 5	3 - 5	10 - 15
Ga	3 - 5	3 - 5	10 - 15
As	1 - 3	1 - 3	4 - 8
Se	1 - 3	1 - 3	4 - 8
Br	1 - 3	1- 3	4 - 8
Rb	1	1 - 3	3 - 5
Sr	1	1 - 3	3 - 5
Zr	1	1 - 3	3 - 5
Mo	1	1 - 3	3 - 5
Ag	6 - 8	40 - 50	20 - 30
Cd	6 - 8	12 - 15	20 - 30
Sn	11 - 15	20 - 25	30 - 40
Sb	12 - 15	15 - 20	30 - 40
Ba	10 - 20	15 - 30	40 - 60
Hg	2 - 4	2 - 4	10 - 15
Tl	2 - 4	2 - 4	10 - 15
Pb	2 - 4	2 - 4	5 - 10

Limits of detection for handheld XRF instrumentation are typically determined using well defined and easily reproduced parameters:

Optimized hardware settings

- X-ray tube target material
- Power (kV, µA)
- Filters
- Background subtraction and/or normalization

Measurement times

- 60 to 120 seconds depending on the element of interest

Interference-free standards

- Standards used to determine instrumentation detection limits typically do not contain anything that introduces other variables, such as interfering elements, unless the hardware settings used eliminate or significantly reduce the interference.

The determination of detection limits for all methods of analysis depend on numerous factors including the instrumentation and its settings, the standards that are utilized to determine the limits of detection, and the actual working samples analyzed.

LODs reported here are based on Innov-X's DELTA Premium, with two different anode configurations, and DELTA Classic;; automatically selected kV-µA-Filter settings; SiO_2 blank measurements; Compton normalization; 120 seconds measurement time; standards that are pure elemental oxides, and NIST standards with some common soil matrices. All measurements were done in air (not under vacuum).

These parameters allow the determination of the best LODs for the handheld XRF being calibrated. Actual working samples may contain interfering elements that the hardware settings or selection of analyte lines do not correct for; therefore, the actual working LODs for "real-world" samples may be higher than those determined with the interference-free standards.

NOTE:

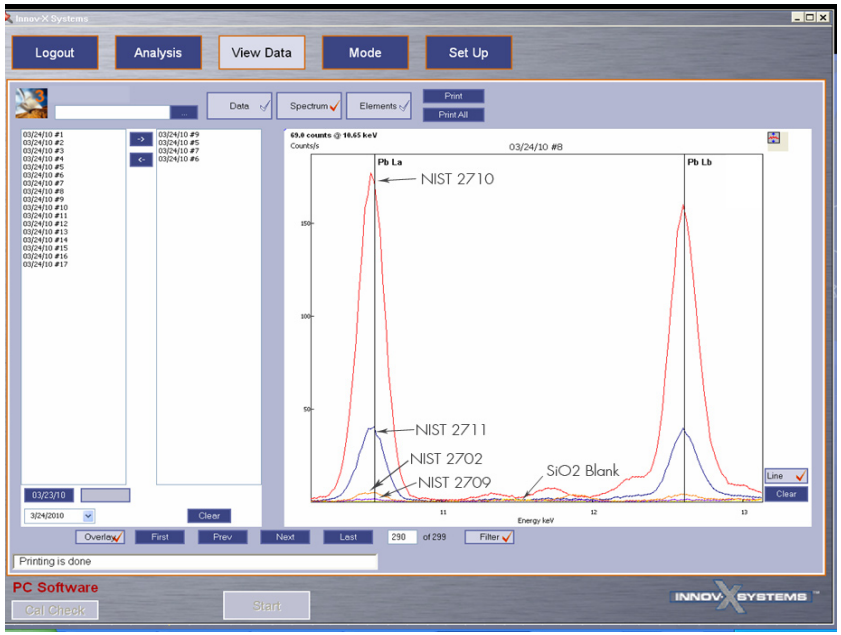
Common, well-known inter-element interferences for environmental real-world soil samples are as follows:

- High levels of Fe can interfere with low levels of Cr
- High levels of Ti can interfere with low levels of Ba
- High levels of Pb can interfere with low levels of As

LIMITS OF DETECTION

Accuracy and precision are important factors with all analysis techniques. Accuracy describes how well the measured results agree with the certified results. Precision describes how reproducible the measured results are. The following data show accuracy and precision results for Lead (Pb) measurements using the DELTA.

A DELTA handheld XRF analyzer, configured in SmartShot Soil analysis mode, was used to measure Lead (Pb) in four NIST soil matrix standards and a blank. As shown below, analysis spectra can be easily overlaid and compared using the Delta PC Software. Here the user has zoomed in on the Pb La and Lb peaks for direct comparison.



Analysis results for the NIST standards are shown at right.

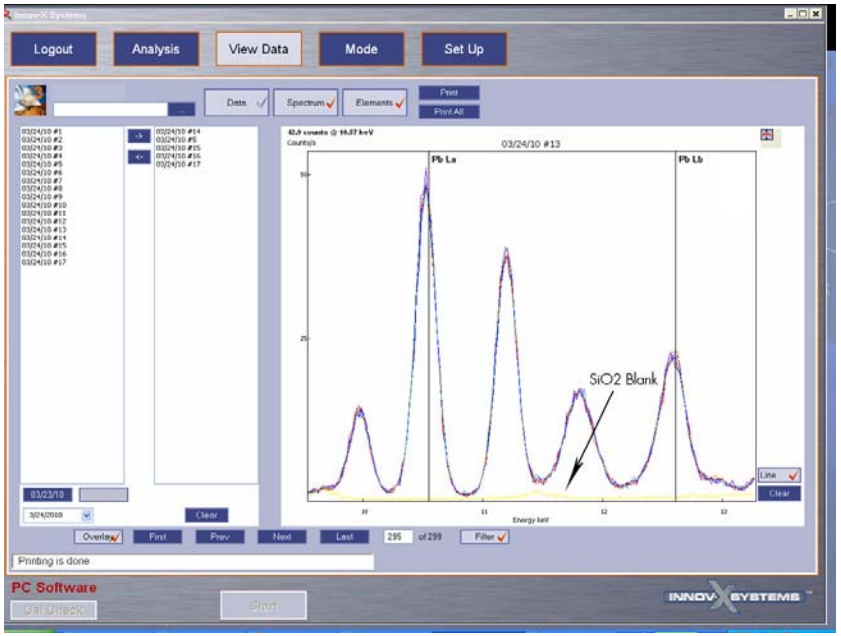
A 60 second measurement time was used.

Results shown in ppm

+/- error shown is 2-sigma, 95% confidence.

NIST Std	Pb Value Given	Pb Value Measured	+/- Measured
SiO_2 Blank	0	<2	-
NIST 2702	132.8	135	4
NIST 2709	18.9	20.2	1.9
NIST 2710	5525	5587	39
NIST 2711	1162	1158	11

A DELTA handheld XRF analyzer, configured in SmartShot soil analysis mode, was used to run repeat measurements on a reference soil sample, to demonstrate repeatability. As shown below, the DELTA PC Software can be used to overlay spectra from different readings for direct comparison and analysis.



A reference sample spiked with approximately 500ppm Pb (Innov-X sample 408) was used for these repeat readings.

Each reading was analyzed for 60 seconds.

+/- error shown is 2-sigma, 95% confidence.

Sample Run	Pb ppm Value	+/-
1	511	7
2	512	7
3	514	7
4	521	7
5	514	7
Avg	514	7

LIMITS OF DETECTION

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