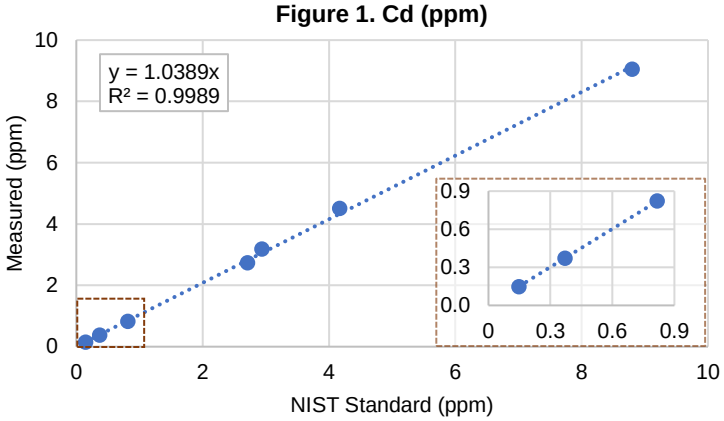
E-max™

Heavy Metal Testing in Soil

Unprecedented Low Cd Detection Limit

E-max uses a monochromatic high-energy beam to optimize Cd analysis. Because monochromatic excitation reduces background by orders of magnitude, it delivers unprecedented Cd LOD as low as 50 ppb for 10 mins testing with minimum sample preparation. It can rapidly survey and quantify low-level Cd contamination in agriculture soil. As shown in Figure 1, it demonstrates excellent accuracy for various NIST soil samples down to 150 ppb level.

Figure 1. Cd (ppm)



Precise Quantification of As

Pb/As interference is a classical issue in XRF analysis. For instance, measuring low-level As with the presence of high-level Pb can be difficult. Due to the reduction of background from monochromatic excitation, the k-beta line of As can be used for solving As concentration when there is interference. A dynamic line-selection scheme is used to determine As/Pb concentration dependent on the presence of Pb, As, Fe, and Br level in a sample, shown in Table 1.

Table 1. Repeats of NIST 2586 (ppm)

Element	As	Pb
1	8.77	448.10
2	9.10	448.87
3	9.18	447.75
4	8.89	448.49
5	8.72	448.35
6	8.28	449.06
7	9.12	447.51
8	8.97	448.04
9	8.56	447.98
10	9.29	447.71
AVG	8.89	448.19
RSV	8.70	432.00
SD	0.31	0.50
RSD	3.5%	0.1%
ACC	2.2%	3.7%

AVG: Average
RSV: Reference Standard Value
SD: Standard Deviation
RSD: Relative Standard Deviation
ACC: Accuracy

NIST Sample Information

NIST	Source
2710a	Montana I Soil Highly Elevated Trace Element Concentrations
1944	New York/New Jersey Waterway Sediment
2586	Trace Elements in Soil Containing Lead From Paint
2711a	Montana II Soil Moderately Elevated Trace Element Concentrations
2782	Industrial Sludge
1646a	Estuarine Sediment
2702	Inorganics in Marine Sediment
2709a	San Joaquin Soil Baseline Trace Element Concentrations
8704	Buffalo River Sediment

For more detailed information, please refer to NIST website https://www.nist.gov/srm

Repeatability and Accuracy

With the fundamental-parameter approach, E-max can be calibrated for wide ranges of soil and sediment matrixes with high accuracy and excellent repeatability, as indicated in Figure 3 to 5 and Table 2.

Figure 3. As (ppm)

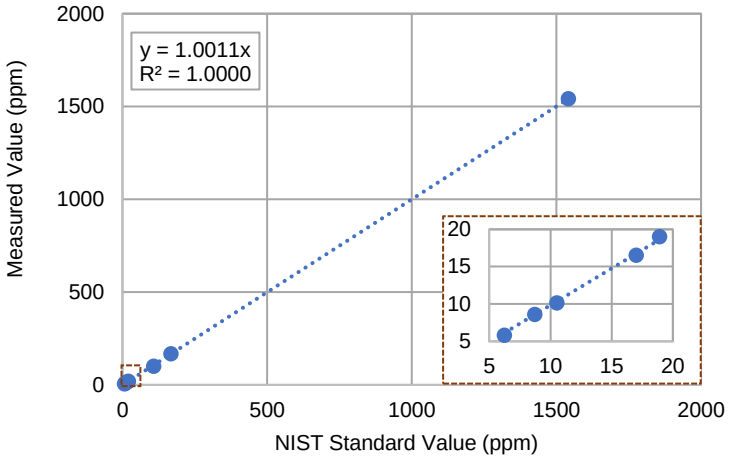


Figure 4. Ni (ppm)

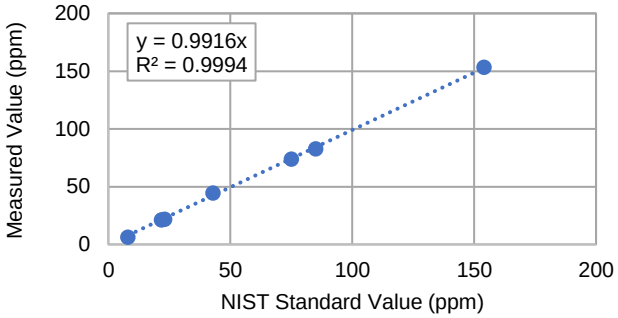


Figure 5. Cr (ppm)

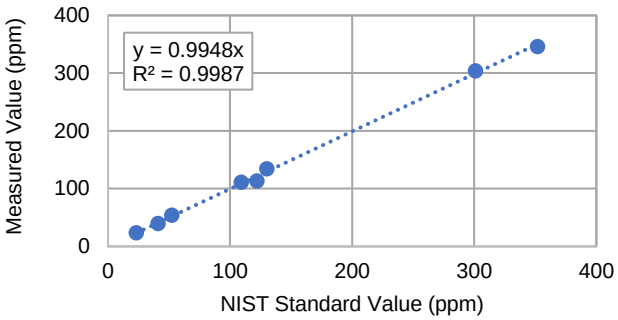


Table 2. Repeats of Reference Standards (ppm)

Elem.	Cd		As		Pb		Ni		Cu		Cr		Hg	
NIST	2709a	2586	1646a	2710a	2709a	2702	1646a	2586	1646a	2710a	1646a	2586	2709a	2711a
1	0.37	2.69	5.88	1547	17.16	137.50	24.90	78.12	9.57	3395	43.30	316.40	1.06	7.30
2	0.39	2.66	5.89	1545	17.17	137.50	25.00	77.40	10.17	3386	41.40	306.90	0.79	7.28
3	0.37	2.72	5.92	1546	17.09	137.50	25.30	78.42	9.97	3385	40.30	308.00	0.75	7.03
4	0.38	2.68	6.00	1543	17.04	137.50	25.00	77.55	9.77	3388	44.00	309.30	0.70	7.04
5	0.40	2.64	5.86	1546	16.81	137.30	25.00	77.45	9.43	3395	43.80	306.70	0.74	7.25
6	0.39	2.69	5.83	1550	17.13	137.50	25.20	77.33	9.97	3388	39.10	308.20	0.98	7.23
7	0.38	2.69	5.79	1537	17.22	137.40	25.10	77.71	9.81	3395	39.80	309.90	0.94	7.02
8	0.40	2.67	5.80	1548	17.23	137.50	24.80	77.71	9.51	3394	39.60	305.50	0.84	6.95
9	0.39	2.70	5.76	1540	17.15	136.30	25.00	77.95	10.17	3388	44.90	312.50	0.70	7.00
10	0.40	2.66	5.84	1545	17.16	136.90	24.50	78.13	9.60	3387	38.90	309.80	0.94	7.04
AVG	0.39	2.68	5.86	1545	17.12	137.30	25.00	77.78	9.80	3390	41.51	309.30	0.84	7.11
RSV	0.37	2.71	6.23	1540	17.10	132.80	23.00	75.00	10.01	3420	40.90	301.00	0.90	7.42
SD	0.01	0.02	0.07	3.64	0.12	0.39	0.21	0.35	0.25	3.96	2.10	3.01	0.12	0.13
RSD	3.1%	0.8%	1.1%	0.2%	0.7%	0.3%	0.8%	0.4%	2.6%	0.1%	5.2%	1.0%	14.5%	1.8%
ACC	4.2%	1.1%	6.0%	0.3%	0.1%	3.4%	8.6%	3.7%	2.1%	0.9%	1.5%	2.8%	6.4%	4.1%

Advantages for low-level Hg and other metals

Measuring Hg in soil at low ppm level by conventional XRF techniques is challenging due to the interference of Pb, As, Zn and other common elements in soil. E-max is able to deliver superior testing of low-level Hg with a monochromatic excitation. E-max can also measure other elements in soil including Mo, Sb, Th and U at an unprecedented low level. Figure 6 shows the results of U and Hg measurement in various NIST samples.

Figure 6. U/Hg