Analysis of Heavy Metals in Soil

HS.HDXRF.15.001

Situation

As part of ongoing efforts to improve the environment and safeguard public health, the Twelfth National People's Congress amended the "Environmental Protection Law of the People's Republic of China" on April 24, 2014. Included in this legislation are provisions for the protection and control of soil pollution. The law directs various levels of government to allocate funds to support environmental remediation.

Rapid economic development in China over the last 50 years has left many former industrial sites contaminated with heavy metals, commonly referred to as "brownfields." These sites were typically located on the perimeter of large cities. As these areas have grown, they are now located in areas that are densely populated. Due to their location, brownfields hold the potential to generate tremendous economic value if they can be remediated and redeveloped for new purposes.

Field Testing

A few of the major steps in environmental remediation include:

- Properly identifying contamination
- Creating a plan for remediation
- Verifying successful remediation once the plan has been executed

Successfully completing these steps requires that detailed information about the amount, location, and types of heavy metals in a brownfield. Because many of these sites are very large, measuring these contaminants with on-site equipment has long been the preferred method because it permits for rapid sample analysis and real time decision making.

Users of existing field measurement technology have experienced some important limitations. Some of the most prevalent and toxic heavy metals require remediation even at very low concentrations. Current technology has an insufficient ability to detect the presence of these contaminants at concentrations that still present hazards to human health. This creates the need to collect samples and send them to off-site laboratories for time-consuming and costly analysis.

The HDXRF Solution

XOS has long been trusted by industry experts and regulators in fields that require:

- Fast results for critical decisions
- Analysis of the most difficult sample types
- Best-in-class detection limits

The HD Rocksand was developed to meet the needs of users in the growing field of environmental remediation. In order to measure the lowest levels of heavy metal contamination, XOS uses their unique HDXRF technology. By using patented Doubly Curved Crystal (DCC) optics, HDXRF is able to eliminate the scattering background from the x-ray source and reduce interferences that prevent detection of low levels of heavy metal contamination. By enabling detection of over 35 elements in the field, expenses are avoided and time is saved by eliminating the need for laboratory analysis of many samples.

Environmental Assessment Quality Control

The US EPA has published a training document, "Advanced Design Application and Data Analysis for FP-XRF in Soil Matrices." It assists environmental consultants, project managers, quality assurance staff, and regulators who are responsible for the design and approval of remediation work plans on the use of XRF to develop and implement strategies for reliable and robust data sets and appropriate sampling. A key element of the US EPA's recommendations is that an initial "Demonstration of Method Applicability" (DMA) be performed. Using this approach, a few key questions can be answered:

- What are the key reasons for doing the environmental evaluation?
- What decisions are in need of data support?
- What is the level of uncertainty that is acceptable to make those decisions?
- How will the data be documented to demonstrate and support the approach used?

The US EPA has found that using real-time, on-site measurement gives managers of remediation work the ability to respond to information quickly and create "dynamic work strategies" that more efficiently accomplish the goals of the evaluation. By performing a DMA, managers can identify the greatest sources of uncertainty, understand relationships with established laboratory methods, and can put alternative strategies if the planned methods are not proving to be adequate.

Field Based Action Levels

A common strategy used during the planning stages of an environmental evaluation is to set up "Field Based Action Levels." These levels delineate the concentration at which: there is little risk that a sample is contaminated, the measured result is inconclusive and should be confirmed by a laboratory method, or the measured sample is clearly contaminated. As part of the recommended quality control plan, the detection limits of the proposed analysis method should be monitored to assure that they are appropriate relative to the actions levels of the contaminants being monitored. If the detection limits are too high relative to the decision being made, the US EPA recommends sending these samples to a laboratory for analysis.

Experiment

A selection of soil reference materials and real world samples were measured by the HD Rocksand analyzer powered by HDXRF®. The real world samples were submitted to an independent laboratory for analysis by ICP. For comparison, the certified values from the reference materials and the ICP results from the real world samples were used to characterize the ability of the HD Rocksand to provide field results for critical decisions below regulatory limits for highly toxic heavy metals such as Cadmium, Arsenic and Mercury.

Results

The results of the experiment can be seen in the figures to the right. After reviewing a number of certified reference materials and real world samples, HD Rocksand is able to achieve results with very good agreement to both certified and laboratory results for the most tightly regulated heavy metals that are commonly found in brownfield sites today. For reference, two of the current regulatory standards in China are displayed.

Conclusion

When designing and executing an environmental assessment, selecting field measurement equipment that is able to identify heavy metal contamination below the regulatory limits is critical to satisfying the critical objectives. The HD Rocksand enables users to eliminate the need for costly and time consuming laboratory analysis for Arsenic, Cadmium and Mercury due to insufficient equipment sensitivity. These results are possible because by of the breakthrough HDXRF technology pioneered by XOS and used in the HD Rocksand.

To learn more about why the HD Rocksand is the ideal field measurement solution for heavy metals in soil, please visit **www.xos.com** or contact us at **info@xos.com.**

Figure 1: Low level Mercury Analysis

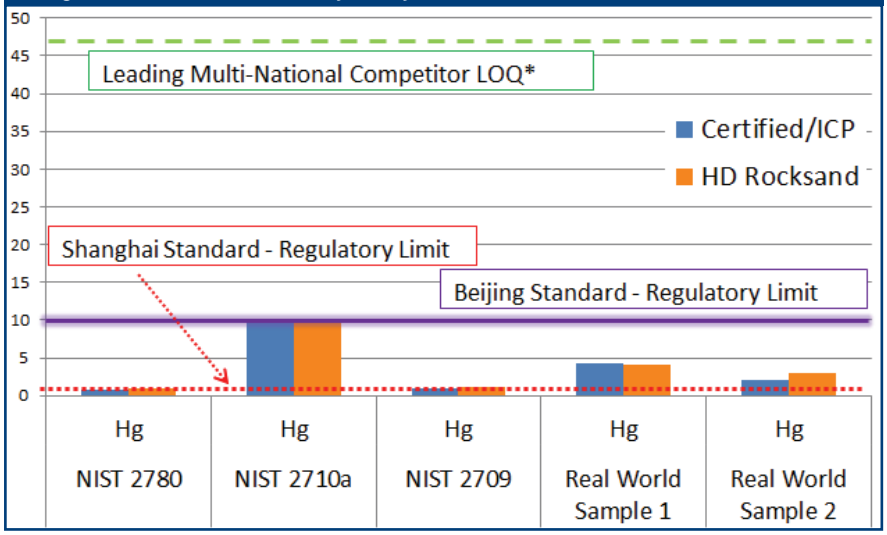


Figure 2: Low level Cadmium Analysis

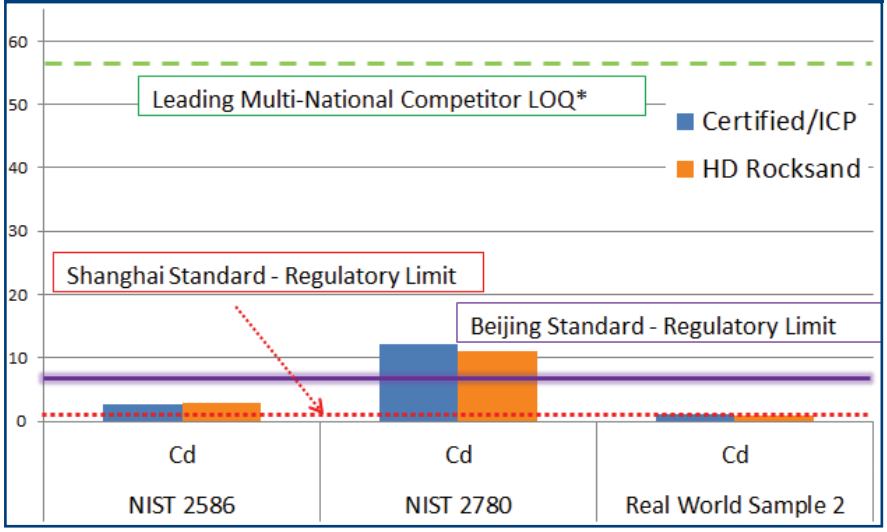
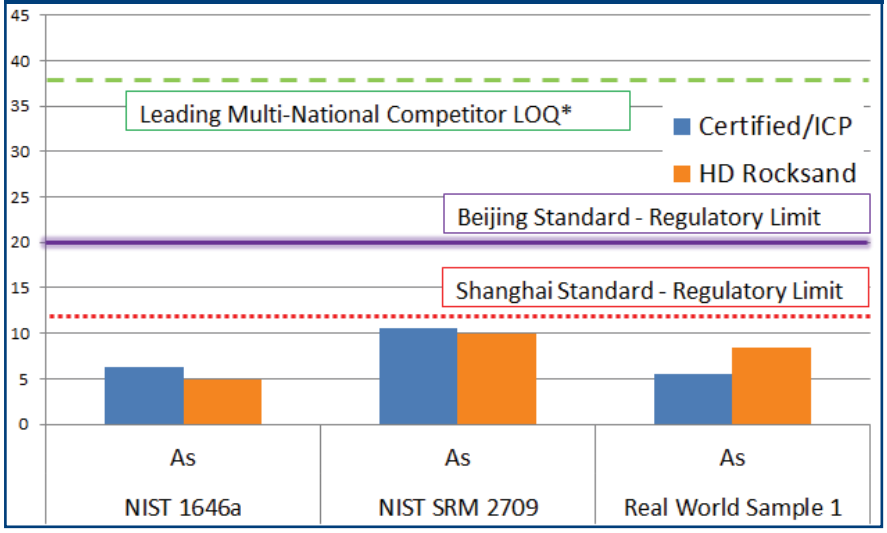


Figure 3: Low level Arsenic Analysis



*LOQ based on published detection limits. Measurement length is 300 seconds. LOQ uses the EPA guideline of three times the detection limit.