| FEATURE

The Future of Respirable Silica Monitoring — Accurate Results Generated On-site in a Few Minutes

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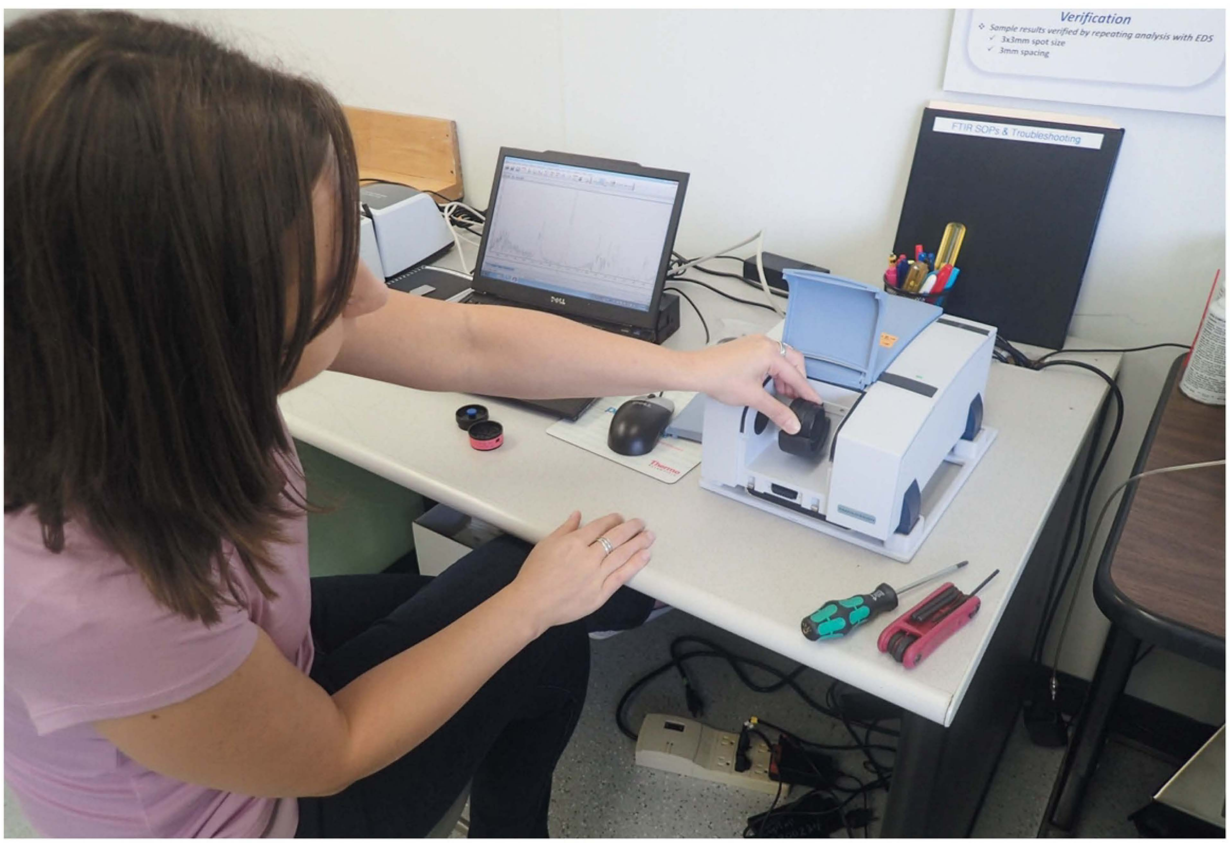
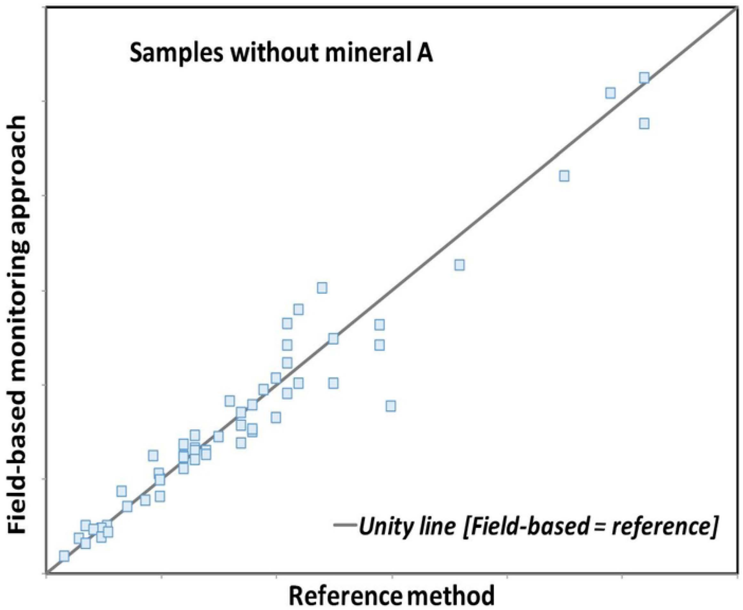
SILICA DUST IS COMMON in many mining environments and there is usually a chance for that dust to become airborne. In aggregates operations, dust may be generated while drilling, blasting, mucking, hauling, crushing, screening, and transferring materials within the plant and to stockpiles. Dust may also be present at customer loadout points and inside quality control labs.



Operators should be fully aware that silica dust is a potential hazard in quarrying operations and workplace exposures should be assessed. Excess exposures can often be reduced using a variety of engineering control technologies and work practices. Controls may include mechanical ventilation, baghouses, water spray systems, enclosed crusher booths, and environmental cabs for vehicles. In addition, respirator use with appropriate employee training and workplace signage is often seen in areas of high dust concentrations.

A well-vetted monitoring approach is essential to evaluating worker exposure and assessing the effectiveness of control technologies. Operators can and do engage in periodic workplace air monitoring, but this practice has its limits. Currently, the most common way to measure the airborne concentration of respirable silica is

Figure 1. BELOW: Model of a common respirable dust sampler and a portable infrared analyzer. BOTTOM: model of a dust sampling cassette inside the analyzer. LEFT: A NIOSH researcher analyzes a dust sample using a portable infrared analyzer.



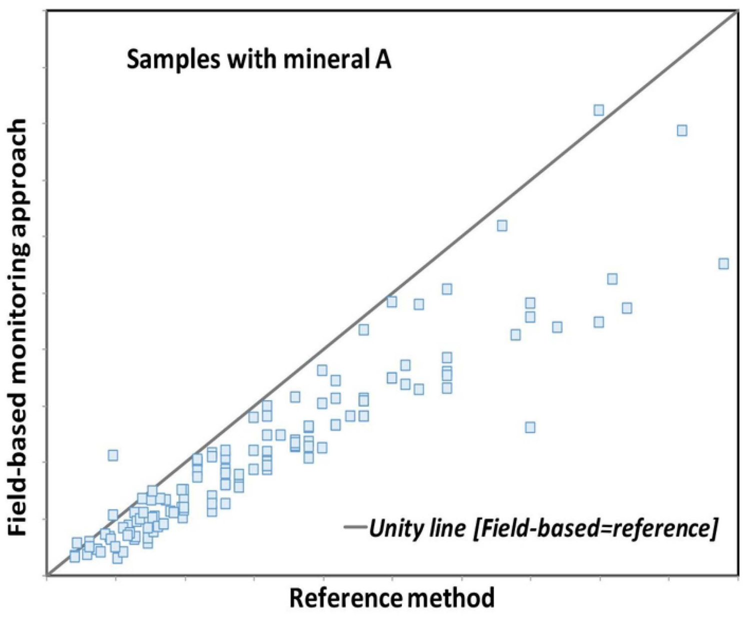


Figure 2. Comparison of our silica estimation results with the reference method (NIOSH7500) TOP: for dust samples without mineral A; BOTTOM: for dust samples with mineral A. The presence of mineral A may induce an underestimation of silica by our method.

to collect one or more respirable dust samples and send the samples to a commercial laboratory for analysis. This practice can be troublesome for several reasons.

First, it typically takes one to two weeks to get lab results back. Moreover, successive samples taken over a longer period than a single work shift may be required to describe exposures in dynamic environments. In the meantime, conditions may have changed where the samples were collected.

What about modern, real-time dust monitors? They may be useful for estimating *relative* airborne dust concentrations, but they cannot distinguish silica from other dust components. Their value assessing absolute silica exposures is thus limited, particularly in significantly heterogeneous ore bodies.

A new approach

NIOSH researchers are developing an innovative silica monitoring approach that would generate silica concentration data right on site, immediately after collecting a respirable dust sample. The research is well underway and the results are very promising. Once the approach is optimized, it will allow occupational health professionals to quickly evaluate *silica exposures*, adjust the control technologies or implement new technologies/interventions, and promptly evaluate the efficacy of the intervention – ultimately giving companies more power to focus resources where they are needed and better protect the health of their workers.

The new approach uses a small, robust, portable infrared analyzer. Several comparable instruments are commercially available, and we're testing them in the lab and in the field to ensure they have the necessary technical and practical features. To perform the analysis of the sample, a standard dust-sampling cassette is inserted directly into the infrared analyzer. In under a minute, a sample can be analyzed specifically for its silica mass and silica concentration. Furthermore, after analysis in the field, the same sample can be sent to a commercial laboratory for comparison by standard analysis.

In creating an effective tool for measuring silica, we knew that – first and foremost – the data generated by the field-based approach must be accurate. When challenged with pure silica dust, our approach showed a limit of quantification of 16 Mμ. The variability in the results generated by analyzing the same samples with two instruments was very low – less than 2 percent. Finally, we've verified that the approach produces results that are consistent over time. Our results proved that the analytical method is robust and it can be used in the field. (MSHA still requires standard lab analysis for compliance samples.)

We also knew that the presence of other minerals in the dust sample can affect the accuracy of the silica results – potentially leading to under- or overestimation of silica – and this issue must also be

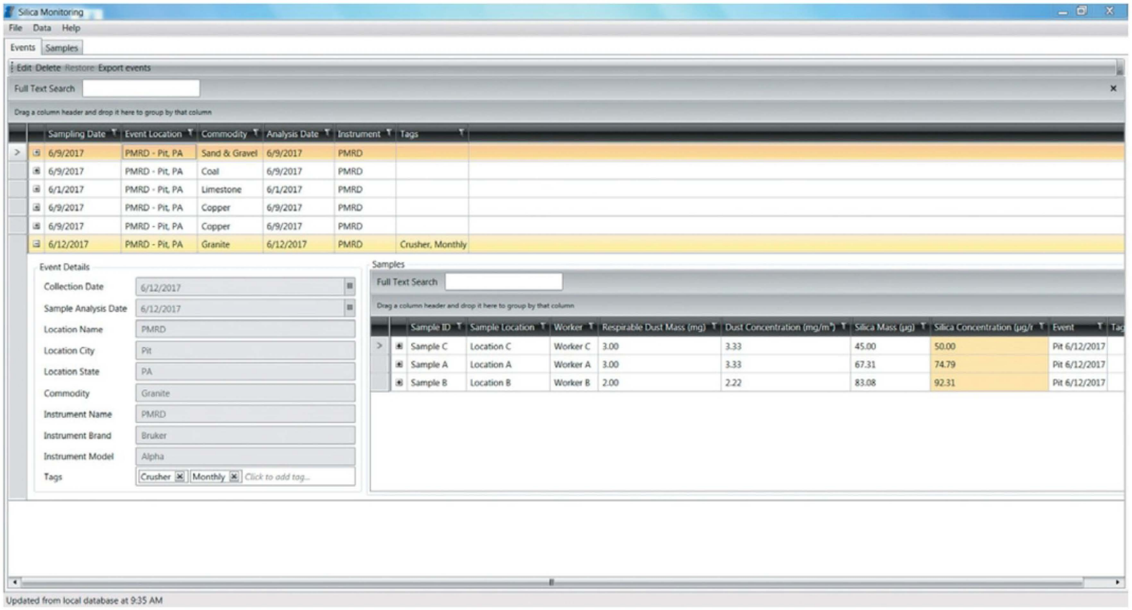


Figure 3. Screen shot of the software under development by NIOSH to be used by occupational health professionals for the field-based silica monitoring approach.

addressed by the new monitoring approach. Therefore, our research is in progress to identify the different airborne minerals that are common in aggregates operations, and to determine how these minerals affect the accuracy of the silica analysis. We can then create appropriate calibration strategies to correct for their presence.

With the help of NSSGA members, we've used this approach over the last two years to test the accuracy of more than 500 dust samples, from limestone, granite and sand and gravel operations. We compared our results with those produced by the standard NIOSH 7500 analysis for silica. Our results will be summarized in an upcoming peer-reviewed publication. From the preliminary analysis, it appears that some specific minerals may negatively affect the silica quantification (see Figure 2). To correct for this confounding effect, we must design a specific calibration strategy.

In addition to being accurate and accounting for the presence of other minerals in the dust sample, we know that the process must also be simple and quick. We are currently modifying the conventional sampling cassette for quick insertion into the portable analyzer – without opening the cassette first.

Finally, with a user-friendly approach in mind, we are also developing software to assist with data analysis and data management to facilitate everyday use of the portable infrared analyzer.

Next steps

To ensure its scientific integrity, our monitoring approach requires substantial testing in the field. We must verify that the final technique is as simple and as beneficial as possible for future users. The equations used to quantify silica concentration must be challenged and optimized with even more dust samples collected in aggregates operations. The new technologies involved in the monitoring approach, including the modified sampling cassette and the NIOSH-developed software, need to be beta-tested and further refined based on user comments.

Finally, feedback from occupational professionals in the mining industry – the intended users for the final technique – will be essential to ensuring that this novel monitoring approach provides accurate, accessible information that will ultimately better protect miners from exposure to respirable silica dust. Beta testing of the overall monitoring approach is scheduled in the next few months, and we look forward to sharing the results.

Disclaimer

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