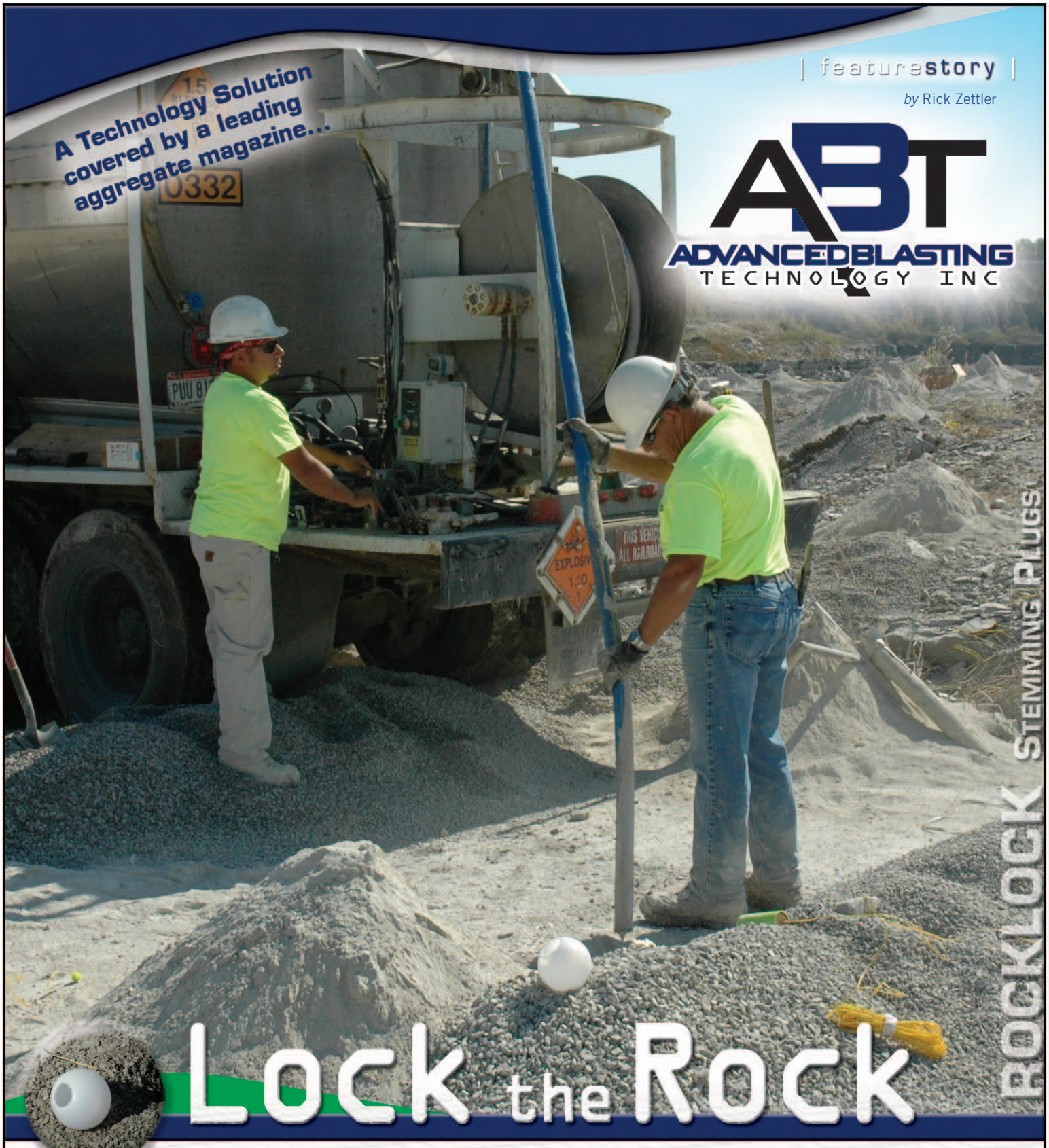


Lock the Rock

Field tests show Rocklock's effectiveness for creating confinement

At any given quarry or mine, a number of challenges can exist that will ultimately affect a blast's performance and subsequent downstream processing. One site may have a seam of cap rock that makes it difficult to achieve uniform fragmentation and muck piles. Another site operating close to houses may have to deck the blast in order to reduce vibration levels, while still other sites may want to improve fragmentation for enhanced crushing efficiency.

Prolonged stemming confinement may allow for explosives to be loaded higher in the borehole to help the fragmentation of cap rock and reduce the occurrence of decking displacement and failure in multiple decked applications.

Many technologies recently introduced have goals of improving blasting efficiencies and performance. Electronic detonators, for example, have minimized the "cap scatter" associated with traditional pyrotechnics, so the blast will perform as designed and improve aggregate fragmentation. However, many of these technological advances have done nothing to contain explosive energy and reduce vertical stemming ejection.

Prolonged stemming material confinement allows explosives to be loaded higher in the borehole to more uniformly break cap rock. It also reduces the occurrence of decking displacement, which affects adjacent charge performance in multiple explosive decking applications. "Achieving explosive energy confinement within the rock mass prevents premature venting and offers better usage of the expanding gasses to improve rock breakage," says Robert McClure, president of R.A. McClure, Inc. and a blasting industry consultant.

ROCKLOCK PLUG

Creating confinement and eliminating the venting of explosive gasses is the concept behind Rocklock stemming plugs, distributed by Watertown, NY-based Advanced Blasting Technologies, Inc. This stemming-filled, high-tensile-strength sphere prevents stemming ejection by absorbing and equalizing the pressure field across the borehole.

Constructed of pliable plastic, Rocklock flexes under explosive loading, creating a frictional gas-impermeable seal.

Filled with stemming, the pliable Rocklock plug prevents stemming ejection by absorbing and equalizing the pressure field across the borehole.

Available in a variety of diameters to match different borehole sizes, blasting technicians simply partially fill the sphere with stemming and drop it down the column. Approximately 1.5 times the borehole's diameter is filled with stemming prior to placement of a Rocklock sphere, and the column is then filled to the top with additional stemming.

By creating confinement, Rocklock allows quarry and mine operations to realize improved blasting safety by reducing the occurrences of fly rock incidents. "Even a couple milliseconds of additional confinement can make a significant difference in enhancing blast performance, curtailing fly rock and improving fragmentation," says McClure.

In applications where decking is used to control vibration, prolonged energy confinement will help to prevent inner deck movement and gas migration. Failure of the deck to maintain confinement may lead to propagation or complete failure of the second charge, which results in poor fragmentation and increased vibration levels.

Operations with cap rock seams may realize gains with the stemming plug. Whereas traditional stemming height limits the amount of explosive, Rocklock enables the explosive to be loaded higher into the borehole for better cap rock fragmentation. "It's an economical alternative to the common practices of satellite hole charges and loading a separate explosive charge in the stemming zone," adds McClure.

POSITIVE FIELD TESTS

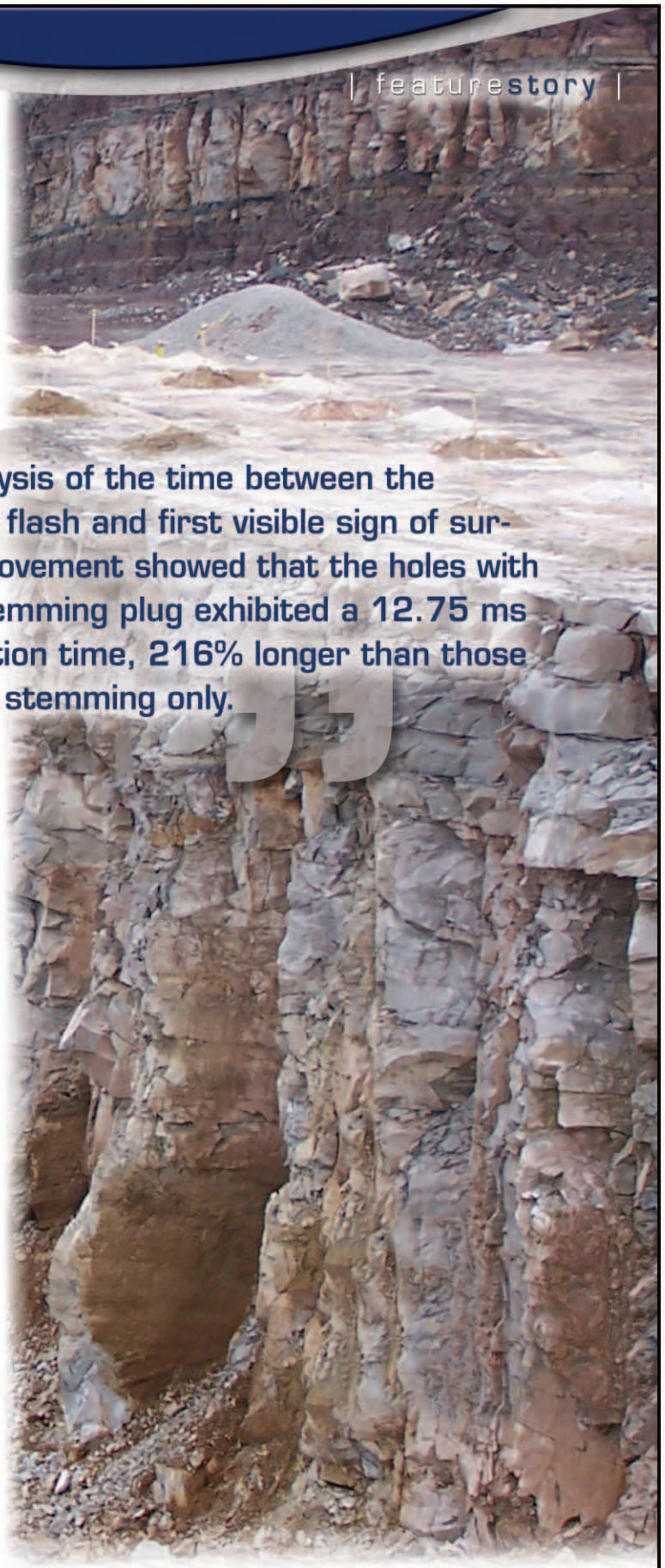
Over the past 13 months, several field evaluations of Rocklock were conducted in both quarry and mine applications. The stemming plug was put through a variety of tests at two limestone quarries in southwest Pennsylvania. "In all studies, high levels of field controls were adhered to during the drilling and blasting process as they related to blast design, bench preparation, pattern layout, drilling and blast hole loading," comments Douglas Bartley, president of DBA Consulting, the company conducting the tests.

> **"Analysis of the time between the signal flash and first visible sign of surface movement showed that the holes with the stemming plug exhibited a 12.75 ms retention time, 216% longer than those with stemming only."**

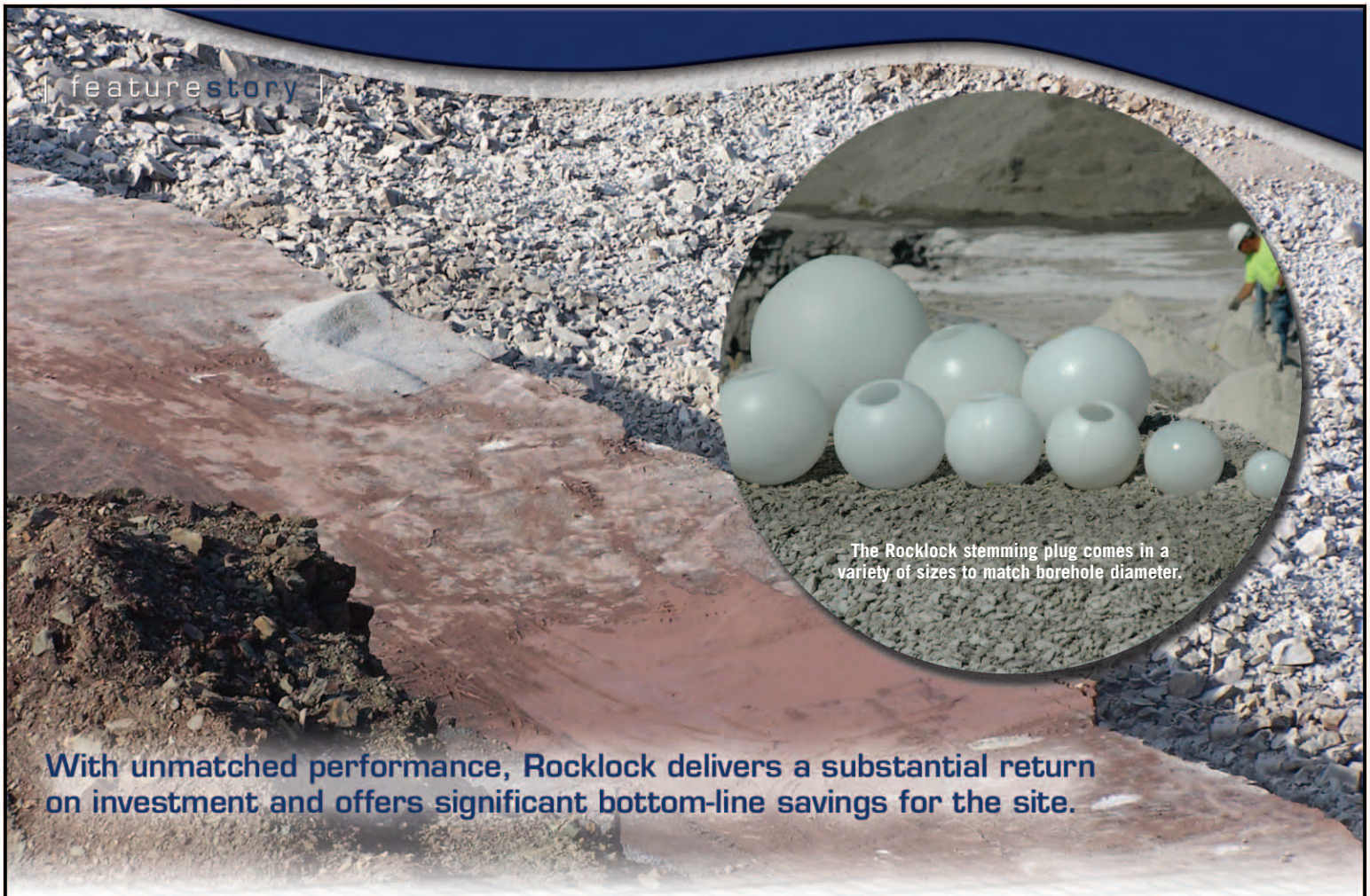
At Pennsylvania Site 1, technicians loaded half of a 69-hole production blast with Rocklock plugs and the other half with a crushed stone stemming material. The blast consisted of two rows of 35 holes drilled to a 58-ft depth and 6.75-in diameter. With a 17-ft burden and 19-ft spacing, the holes were loaded with bulk emulsion explosive and detonated with a non-electric shock tube system. A portion of the holes in the center of the blast were identified with signal indicators.

The technicians performed a post-blast analysis using a 1000-frame-per-second high speed digital video camera. Analysis of the time between the signal flash and first visible sign of surface movement showed that the holes with the stemming plug exhibited a 12.75 ms retention time, 216 percent longer than those with stemming only.

Fragmentation data were also gathered and analyzed using a digital analysis system. The merged fragmentation data revealed that the stemming plugs produced a slightly higher degree of rock fragmentation - an 8 percent decrease in the D90 (90 percent passing) screen size to 8.41 in - with a more uniform size distribution. "Improved fragmentation and uniformity of aggregate material yields quicker excavation and hauling times, more efficient crusher throughput and lower crushing costs," says McClure.



A series of Rocklock field evaluations was conducted in both quarry and mine applications to assess the stemming plug's effectiveness for improving confinement.



The Rocklock stemming plug comes in a variety of sizes to match borehole diameter.

With unmatched performance, Rocklock delivers a substantial return on investment and offers significant bottom-line savings for the site.

Similar results were found at Pennsylvania Site 2, which featured a series of five analyzed blasts. The first and last blasts included only stemming material, while blasts two through four included stemming plus Rocklock. This time, the 6-in diameter borehole was loaded with a 40 percent bulk emulsion blend and detonated with electronic detonators.

The merged fragmentation data showed the Rocklock post-blast muck piles were composed of a higher degree of fragmented rock with more uniform size distribution. The difference in average mean size was 15 percent smaller with Rocklock versus stemming only.

Surface swell above the opening hole indicated that the stemming plugs contained the expanded gases an average of 17 percent longer than non-plugged holes. "These findings suggest that the longer the energy is contained, the better the rock fragmentation," explains McClure.

GOLDEN RESULTS

At a gold mine in Alaska, DBA Consulting analyzed a 156-hole production blast in which 48 holes were loaded with 21 feet of ANFO, a Rocklock plug and 1.25- to 1.75-in stemming. The other 108 holes received ANFO and crushed rock stemming. Video analysis of the blast revealed that the portion of the blast loaded with stemming plugs contained the gas energy much better than the holes without the plugs. "The area of the bench containing the hole plugs exhibited a reduced amount of stemming ejection," says Bartley.

Vertical swell of the muck pile from the plugged 48-hole section was noticeably higher than the non-plugged areas. "This suggests that the rock in this area received a more sustained gas pressure pulse," adds Bartley.

Whether it is cap rock, a decking application or an effort to improve fragmentation, these field tests show the many benefits of creating confinement through the use of Rocklock. "Stemming plugs offer an easy-to-use and cost-effective method for creating this confinement to improve blasting safety and performance," concludes McClure.

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