SUCCESS *in the field*

Producers Evaluate Sonic Drilling Technology

In the November 1998 issue of *Aggregates Manage*r, the article "Sonic Exploration for Aggregates: A Better Way," reported on the use of a relatively new subsurface technology—sonic, for exploration of aggregate reserves.

As noted in the article, key advantages of sonic rigs include the ability to collect continuous core samples through almost any type of overburden without using air or fluids, no depth restriction, speed, safety, the ability to continue from overburden into bedrock, and the ability to quickly deal with down-hole problems such as heaving sand, cobbles and boulders, and other situations that can affect efficiency.

Since then, sonic rigs have performed numerous sand and gravel and/or limestone projects for many producers. So what has been the feedback from users?

Dick Martin of Hilltop Resources compared the results obtained with the sonic rigs to those found with the dual-tube air rotary method. Martin decided that while he likes both systems, he "prefers the sonic for its superior logging ability." He also noted that the rotary operation is too fast and difficult to accurately log when cuttings are discharged out of the diverter into a pile.

Setting up the sonic rig at a job site in Cincinnati, Ohio.

After seeing a sonic rig at a competitor's quarry, Dan Balkema of Balkema Excavating said he felt the sonic rig would give the kind of cross-section he needed to see. Todd Greenwood, geotechnical engineer for North American Reserve, said, "Sonic technology allowed us to determine the quality and estimate the quantity of aggregates at previously unmined areas faster and with better results for the extensive depths needed." Bob Mill, vice president of The Shelly Company, said, "The sonic process is much faster, but most of all you can get a more representative sample of the material you are drilling. It gives you a true cross-section of the strata to almost any depth you wish to drill."

INVESTIGATIVE RESULTS WITH SONIC

In many cases, producers said that the standard 4-in.-diameter core sample obtained with sonic rigs gave better sample representation than traditional split-spoon sampling methods. The 4-in.-diameter core sample provides accurate gradation except in deposits composed of large amounts of cobbles and boulders. For larger samples some producers prefer, 6- and 8-in. diameters are now available. The cost for these larger samples, however, increases significantly, to as much as 80 percent per ft. for a 6-in.-diameter core and 280 percent for an 8-in.-diameter core.

In addition, with the increased core sizes, speed of production slows. As Mill said, "The size of the sample could always be larger to get good gradation results, but I feel that we have obtained some good data with the samples we received."

Most of the sonic rig investigation projects conducted so far involved expansion of existing quarries or gravel pits or prospective sites with options secured on the land. With their ever-present need to secure future reserves, producers are especially interested in technology that will help them make informed decisions based on accurate information. Balkema reported that the sonic rig accurately showed the lower formation on a particular site, keeping him from obtaining equipment to mine deeper. On another site, a greenfield location, the sonic rig gave Balkema the information to confirm what he had heard about the site.

Information provided by the sonic rig also made another producer's decision easier: the sample accuracy, especially below the water table, convinced the producer that the deposit had too high a percentage of sand and not enough gravel. Also, all-clay lenses and other undesirable materials were apparent in detail. As a result, the producer decided not to pursue the site.

GEOLOGIC CHALLENGES

Some sites present specific challenges or geologic conditions such as heaving sands, cobbles and boulders, deep granular formations, very dense sand and gravel (too many blows for a 3-in. spoon with a 300-lb. hammer), stratified formations, formations laden with rock fragments, overconsolidated tills and other challenging situations that limit the usefulness of most methods. Except with the sonic rig, these conditions can make it difficult or even impossible, to retrieve quality samples with accurate logging in a timely manner.

PRODUCTION RATE/SPEED/SAMPLE RECOVERY

As previously reported, average sonic rig production rates range from 150 to 200 ft. per day of drilling with continuous sampling. Variables to the production rate include the formations encountered, the depths of the borings, the length of the sample run, access and other factors. For example, making 20-ft. sample runs on a group of 80-ft. borings could yield four in a day, while completing a 150-ft. hole with 10-ft. sample runs could take a day.

One producer from northern Ohio reported his average recovery from split-spoon samples as being in the 50 to 60 percent range. He found the sonic rig provided an average of 93 percent recovery over 17 holes. This same producer said hollow-stem augering with split-spoon sampling, while cheaper per foot, is time-consuming and gives poor results in non-cohesive material below the water table. Straight augering with solid augers, he said, provides no reliable sample.

Greenwood said that the sample recovery was very good after exceeding 20 ft. below ground surface.

SONIC CHALLENGES

No drilling method is perfect, nor is the use of sonic rigs. Feedback provided by producers identified four areas for considera-

tion: recovery, water usage, cost and availability.

Recovery—According to Balkema, on a few runs, a cobble just larger than the core barrel lodged in the bit, resulting in poor recovery. One possible remedy would be to stop a core run after contacting large cobbles or boulders to ensure the material below is not prevented from entering the core barrel.

Martin said that although sample volume was good and recovery was 100 percent, it looked like 60 to 80 percent after slumping in the container bag, which made it a little harder to log. This condition can occur in sand and gravel formations when a 4-in. x 10-ft. sample is emptied into a 6-in. bag that slides over the outside of the core barrel. Such "slumping" inside the sample container sleeve can be prevented by extruding the sample 5-ft. at a time, taking more care in the sample extrusion process, or using 4-in. butyrate liners. The liners, however, increase the cost of the process and have not proven to be 100-percent successful.

Water Usage—Although the core barrel is advanced without water or air, the casing that is advanced over the outside of the core barrel is usually run with water. This isn't a problem for the producers as long as they have a viable water source and dozer assistance isn't needed for access to the water supply source or back to the boring location. Water hauling issues are typically taken care of prior to access, between locations or at the beginning of the day.

Cost—Prospects used to seeing an auger quote with intermittent 2-in. split spoons for $10 to $12/ft. and intermittent 3-in. spoons for $12 to $15/ft. have acknowledged a little "sticker shock" at a sonic quote. But the only core sample delivery comparable to sonic is hollow-stem auger (HSA) with continuous 3-in. spoons, or the 3-in. and/or 4-in. x 5-ft. continuous sampler. That continuous sampler costs $16 to $22/ft. down to 50 ft., jumping to $22 to $30/ft. in the interval from 50 to 100 ft. Costs jump considerably higher for those firms willing to go deeper than 100 ft. The sonic cost is in the $20 to $40/ft. range down to 100 ft., increasing about $5/ft. in 50-ft. increments thereafter for continuous 4-in. core sample delivery.

A 4-in.-diameter x 10-ft.-long sample at the Springfield, Ohio, site.

Mill said, "Probably the two downsides I have experienced are the cost and the availability due to the limited amount of sonic rigs in our area." He noted, however, that he believes you get a very good value with the sonic rigs and said he has already recommended sonic exploration to a number of his fellow producers.

Said Greenwood, "Although initial costs of sonic technology exceed conventional methods, the slow production rates and delays attributed to down time with traditional methods may actually exceed the final cost when comparing these methods to sonic technology. In my experience, sonic technology is the number one choice for subsurface exploration with multiple soil borings and depths greater than 50 ft."

Availability—Many firms have called to check availability and are surprised to hear that the sonic rigs can be backlogged for several weeks or longer. Experience has shown that availability can range from immediate to six weeks based on seasonal fluctuations and environmental workloads. With the limited number of sonic rigs in the country, planning can be important.

OTHER SONIC APPLICATIONS

Sonic rigs can be used for other applications related to the aggregate industry. These include drilling for water wells, monitoring wells, dewatering wells, site reclamation planning, blasting planning and borrow material investigations.

PROVING VS. PREDICTING RESERVES

At a presentation during an Indiana Mineral Aggregates Association workshop, it was shown that one exploratory boring per 10 acres on an 80-acre site (eight borings) amounted to $0.002 per mined ton of reserves. Increasing the number of borings by four-fold is still less than a penny per ton, yet goes a long way towards distinguishing between "predicted" and "proven."

As Mill said, "…it is much easier to prove reserves with sonic. When I am drilling a greenfield site, I will always request a sonic rig over any other method."

Just as important as the number of borings to an adequate investigation is the accuracy of the samples. The sonic method warrants serious consideration when a producer is looking for the quality and accuracy necessary to justify the capital investment of selected property. ▲

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the bottom line

Many producers are choosing the sonic drilling option for investigation of their sites and are happy with the results. Even when poor formations are encountered, though, a quick "go/no-go" decision can be made. The quality of stratigraphic information coupled with high production rates makes this method worth investigating. Sonic Rigs also face challenges in certain situations. Limitations include: recovery, which has the best *in-situ* type yield of any drilling method and can be further improved with sample extrusion care or the use of liners; water usage, which is not a significant factor for producers unless it involves access assistance; cost, which can be mitigated by production and the quality of the sample obtained including comparison to HSA; and availability, which can be addressed with adequate planning.